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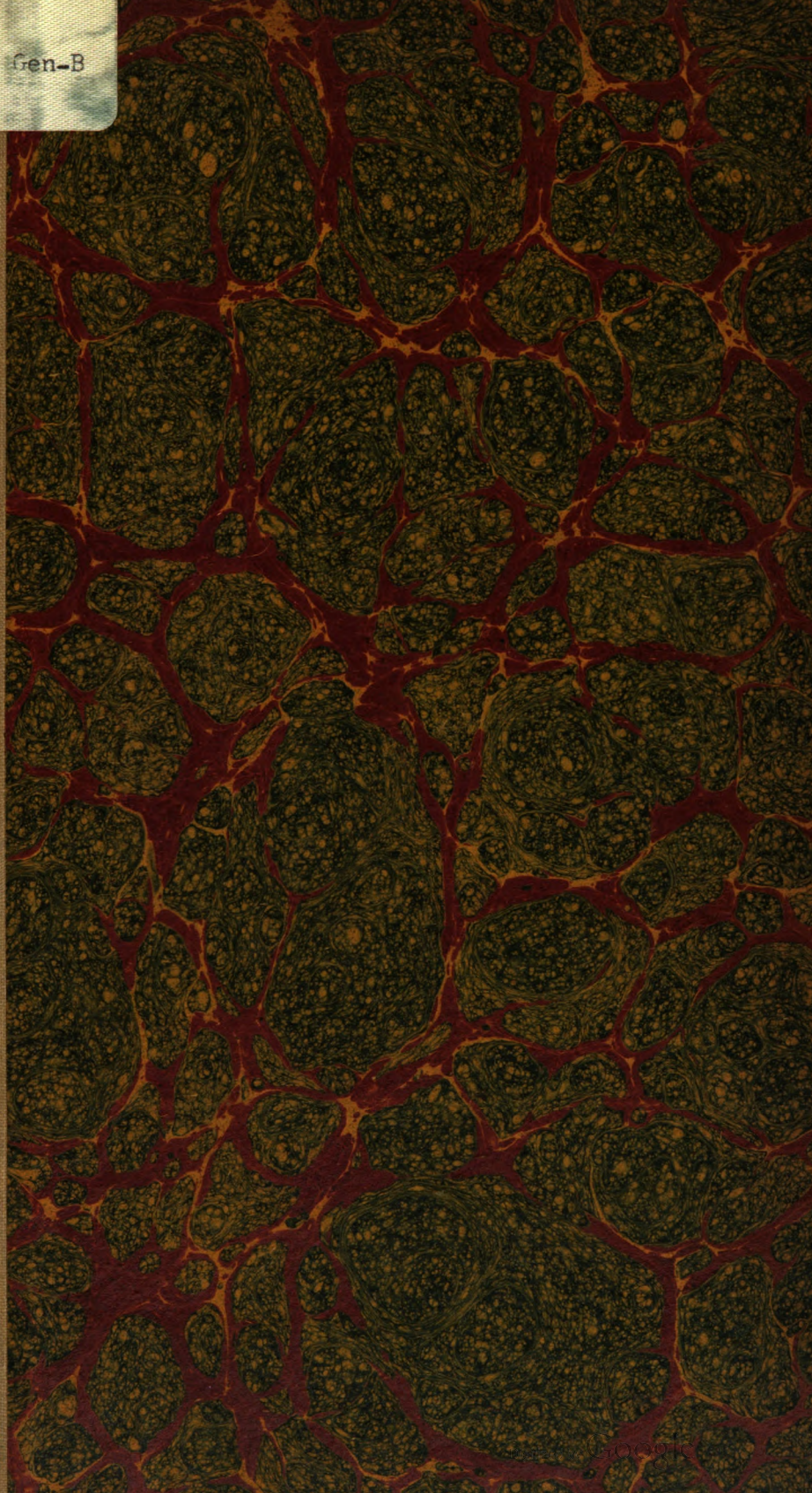
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BULLETIN

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VOL. III.

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ARTICLE II.—*Insects Injurious to Young Trees on Tree Claims.*

BY LAWRENCE BRUNER, ENTOMOLOGIST.

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DISTRIBUTED JUNE 7, 1890.

LINCOLN, NEBRASKA,  
U. S. A.



ARTICLE II.—*Insects Injurious to Young Trees on Tree Claims.*

By LAWRENCE BRUNER, Entomologist.

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SIR: Herewith is presented for your consideration a short report on some of our most injurious insect enemies of young trees such as are grown upon tree-claims, homesteads, and farms, for wind-breaks and fuel, here in Nebraska, thinking that, perhaps, it might be of use to those who are cultivating these trees.

In the preparation of this report only such of the insect foes have been treated as are especially destructive to the trees while they are still small, and that commit their injuries by destroying the foliage rather than the woody portion and roots of the tree. A great many other insects might have been added to the list; but, as the present paper is only intended to include "defoliators," they have been omitted. Many of these latter have been treated in Bulletin No. 7 of the United States Entomological Commission, entitled "Insects Injurious to Forest and Shade Trees."

Considerable space has been devoted to each of the species treated, while the text is made clearer by the addition of many explanatory illustrations of both the injurious species and their insect enemies that assist us in keeping them in check. In addition to a general introductory chapter on the causes for the increase and spread of these injurious insects, together with modes of prevention, remedies have been suggested in each case after the life-history of one of them has been given.

No claim for originality is made for this paper, because it is a compilation, or a bringing together from many sources, of such facts and notes as relate to the class of insects that are being dealt with. Most of the authors from whom I have quoted or borrowed my ideas are given credit in the text of the work, as are also those from whom the illustrations were obtained.

I am under obligations to Prof. I. H. Orcutt, of the South Dakota Agricultural Experiment Station, and to Mr. C. G. Brackett, Secretary of the Kansas Horticultural Society, for the use of a number of the electrotypes used in illustrating the species treated.

LEWIS E. HICKS,  
*Director.*

LAWRENCE BRUNER,  
*Entomologist.*



## INTRODUCTION.

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For several years the writer has been greatly interested in such of our injurious insects as occur here in the West, and make themselves especially obnoxious to the settler by attacking and defoliating young trees other than fruit trees. This interest was first aroused by the reports which reached me of insect depredations upon tree-claims located in the semi-arid region lying to the westward of the 97th meridian, and afterwards accelerated by personal experience in that region. A slight investigation has been sufficient to convince me that the ravages of insects upon tree-claims have been great and quite general. It is to aid the settler in preventing, at least to some extent, the further injuries from this source, that time has been spent to prepare the following paper.

A very little investigation into the subject has been necessary to ascertain facts of sufficient importance to warrant a continuation of the study. It was learned how very frequent are the failures for being unable to "prove up" at the proper time directly traceable to the ravages of insects, although in some instances the settlers were themselves ignorant as to the causes of failure in their trees. Not unfrequently has it been the misfortune for those striving to gain titles to government lands by taking advantage of the timber culture act, to have their trees completely defoliated repeatedly for several years in succession. Nor have these injuries been confined to any single kind of tree. Since commencing this study of the subject, the following-named trees have been ascertained to suffer alike from this cause: ash, box-elder, soft maple, elm, walnut, cottonwood, and willows. The honey-locust, too, has been subject to defoliation by insect enemies when growing in hedges or in groves upon the uplands of this semi-arid region; while various other shade and ornamental trees growing along the streets of the cities and towns, and in public parks, have suffered likewise from the same cause. Some of these trees, when thus attacked and stripped of their foliage, are killed outright, while others are set back a year or more by each defoliation.



Several different lines of investigation have been followed in the study of this subject; such, for example, as the comparative freedom from attack by insect foes of the various kinds of trees usually grown; the influence of climatic conditions and topography of the country upon the growth of each kind of tree; as well as the influence of these conditions upon the development and increase of the insect life thriving upon it. The comparative abundance or absence of birds and parasitic insects in the different regions, and what relation these bear to insect depredations, have also received consideration. Of course, when fully carried out in these several lines of investigation, as indicated above, the subject cannot fail to result in some good to the parties most interested. Even if the entire line of work has not been completed, some of it has at least, and will now be given to the public for what it is worth.

As before stated, a large list of these injurious tree pests has been made. For the present, however, only a few of the most important of these will be considered. Of these there are about thirty species that belong to the following orders, as insects are separated by the naturalists: Coleoptera, Hymenoptera, Lepidoptera, Orthoptera, and Hemiptera. Most of these insects to which I wish to call attention, are quite general in their distribution, and are therefore quite as well known to those living beyond the confines of the "tree-claim" region as they are to those living in it. My report will, then, consist simply of a statement as to their abundance, distribution, and the amount of injury done by each species. All of these insects herein mentioned have been either observed by myself or have been reported to me by others as occurring in injurious numbers during different seasons upon tree-claims located in the States of Nebraska, Kansas, and Dakota. Most all of them, too, are sufficiently numerous at times, when working alone, to kill, or at least to greatly injure, and thereby retard the growth of the tree or trees upon which they feed. Of course they do not all occur at once in any given locality in such overwhelming numbers, nor are their injuries the same every year; but quite frequently two or more of the species are found feeding in company upon the same tree in numbers sufficiently great to do harm. In addition to the species about to be described, there are a great many others, as has already been stated, that are also known to attack and injure the young trees growing upon tree-claims. These latter have not yet made their

presence so strongly felt as to compel us to place them on the list of insect pests in connection with tree-claim culture. For a description and life-history of many of these, the reader is referred to Bulletin No. 7 of the United States Entomological Commission, entitled "*Insects Injurious to Forest and Shade Trees.*"\*

#### CAUSES FOR THESE INSECT INJURIES.

"There is a cause for everything;" so in the present instance we must look for a cause, or a combination of causes, that work together in producing the undue increase of insect life far out upon the prairies when new plants are introduced. Notwithstanding the fact that one would hardly suppose them capable of reaching these out-of-the-way places, they nevertheless do; and how it is done a very superficial survey of the ground will quickly and plainly reveal. After the insects have found the new food-plants, it will be easily seen how they are permitted, in fact aided, to increase rapidly. In the first place, there are always a few dwarfed native trees of most of the kinds that are usually planted upon claims, close at hand. These trees, as most of us who have traversed prairie countries know, are scattered along the water courses, in ravines and gulches, and a few other such localities as are protected from the fires that have annually swept over the broad prairies for generations. These few trees furnish food and refuge for small colonies of the various species of insects that we have named or referred to above. There are always enough of them to very quickly stock a claim close by upon which small trees have been planted that are to their taste. Then, too, all of these injurious insects are of a hardy nature, used to a precarious existence, and are strong fliers, capable of making comparatively long journeys in search of food for themselves and their progeny. They are in fact the nomads of the insect world, capable of withstanding the vicissitudes belonging to a life upon the vast prairies where the more delicate parasitic forms could not live or even find the necessary shelter which they require. Then, too, their requirements for quarters in which to pass the long, cold winter months are less complex than are those of the species that are introduced later on in the settlement of the country.

Nature has favored some kinds of insects much more than others, so that they are better prepared to hold their own in their struggle for

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\* By A. S. Packard, Washington, 1881, pp. 275, 100 illustrations.

existence. They have been provided with natural means for protecting themselves against the ordinary vertebrate and insect enemies that attack other forms not so protected. These natural means of protection are usually in the form of glands for secreting offensive odors, repulsive fluids, etc., or in the presence of bristles, thorns, and other surface coverings. Other forms are protected in their larval stage by the utilization of their excreta for constructing a covering or case within which they live with comparative safety. Most of the species of insects mentioned in the present bulletin belong to this class. They are all more or less perfectly protected against enemies. In the second place, the country being destitute of groves of timber among the branches of which and around the roots of which *birds* can find shelter and suitable places in which to build their nests and rear their young, most of these insect destroyers are absent. Of course, the absence alone of so great a factor as are these birds in the keeping down and ridding a country of its insect pests soon becomes apparent in the increase of and accompanying damages done by them. The absence of groves not only keeps away the feathered tribe, but also prevents many of the more delicate parasitic as well as a large number of the predaceous insects from becoming established in the region. The majority of these latter forms of insects, as before stated, are such as require sheltered retreats in which to lurk or to get away from the hot dry summers and the long cold winters. Besides bird and insect friends that are absent from the region at the opening up of these new homes, there are also fewer of the small insectivorous mammals than later on after more shelter has been provided for them. This, too, has a decided effect upon the increase of insect enemies.

In the third place, the comparative aridity of the region where these claims are located renders tree growth somewhat slower than where the precipitation of moisture is more bountiful. This slowness of growth, while it is an advantage in one respect, aids the insect foes to a considerable extent in their work of destruction. A rank and rapid growth places a tree out of danger from external enemies much more quickly than will a slow growth. At the same time, in a rank growth, a much greater amount of food is furnished for the same number of insects, and as a consequence, less injury results than if the growth were slower.

A fourth cause for the rapid increase among the different insects in

new regions, is the absence of fungoid diseases, such as are known to attack and kill various of these pests. After a while, however, the germs or spores of these diseases become diffused through the soil, vegetable *debris*, and about the incumbering growths, buildings, etc. These spores are carried about by the elements and other agencies, and in time some of them find lodgment within the bodies of such insects as are susceptible to their growth. The result is disease and death.

#### COMPARATIVE FREEDOM OF DIFFERENT TREES FROM THE ATTACKS OF INSECT ENEMIES.

Up to the present time I have not given sufficient time and study to this particular part of the subject to enable me to write authoritatively. But this much can be said: while no tree is entirely exempt from the attacks of insects, some kinds are more nearly so than others. This can very readily be seen at any time where several different kinds are growing side by side in the same grove. Again, a particular kind of tree might be troubled in a given locality, while in another it would be comparatively free. Some trees also suffer while small, and others are usually injured after they have gained considerable size and age. These variations with regard to immunity from insect attacks among different trees, and of the same kind at different ages, are governed by laws the explanation of which would require much more time and space than could be given here. By carefully looking over the succeeding pages, it will be seen that no reference is made to insects injuring the Russian mulberry. The catalpa is affected by but three, while the ash is injured by three, each of which, at times, strip it of foliage while young; the box-elder, by two or three; the willow, by a dozen or more; the cottonwood, nearly as many; the soft maple, by several; the elm, a couple; the honey locust, two; etc.

In treating this subject, only such insects have been mentioned as are known to injure the various trees during their first few years of growth, and before they have attained any great size. Other species of insects commence their injuries to these trees later on, but, as a rule, these latter are less destructive to them, save in a few instances. Only a very few borers work in healthy young trees over the region embraced in the report.

## REMEDIES TRIED AND SUGGESTED.

Only a few remedies have been generally tried against these pests in the region of tree-claims, and most of these were confined to the various methods of "hand picking" and crushing. Spraying and dusting with poisons, kerosene emulsions, or the use of road dust, ashes, air-slaked lime, etc., have been reported only in a very few instances. Any or all of these methods of warfare, when properly carried on, and used intelligently in accordance with the habits of the insect that is being fought, will repay one for the time thus spent.

For specific remedies, the reader is referred to the head of *Remedies*, under each of the species of insects treated in the following pages; and to the appendix where these remedies are more fully explained.

## THE CECROPIA SILK-WORM.

(*Platysamia cecropia* Linn.)

The insect which is illustrated in its different stages in Figs. 1 to 3 certainly is a beauty, and is by all odds the one most frequently referred to the entomologist for name and other information concerning its life history and habits. This seeming desire for information on the part of the general public can be credited to mere curiosity, rather than to any real desire for information, since the insect is a very common, as well as conspicuous, one in its various stages of growth. This silk-worm and its moth have been the theme for many a newspaper and magazine article; besides, school books have not been without their words of praise concerning it. All this being true, we can hardly conceive of how a person can grow to manhood or womanhood without learning the name, at least, of so common and withal, beautiful and conspicuous an insect. If we observe as we go through life, and remember what we see, there can be no excuse for our remaining in ignorance. The power to observe is ours, and we should use this power, yes, cultivate it.

The Cecropia moth, in addition to its conspicuousness, is also noted as being one of the largest representatives of the group of insects popularly known as silk-worms; and, in this connection, is an object of interest to many. The great size, too, of the insect in its different stages of growth renders it easily seen, while its wide distribution and multiplicity of food plants make it one of our most common insects. It is not, however, as an object of beauty, nor yet as one of economic value, that I now take up its life history. On the contrary, as an enemy to tree-culture, this insect has no equal in some portions of this region. Its large larvæ often become so numerous as to completely strip entire groves of their foliage.

This insect is classed with the extensive family of moths to which belong a large number of the tree-feeding species, viz., the Bombycidae. These moths are characterized by their larvæ being more or less hairy, or ornamented with spines and tubercles; also, in that they, as a rule, spin silken cocoons, in which the transformations from larva to pupa and from the latter to the moth take place.

The moth, or perfect insect, (Fig. 1) can be briefly described as follows: wing expanse, five to six and five-tenths, or even seven inches.

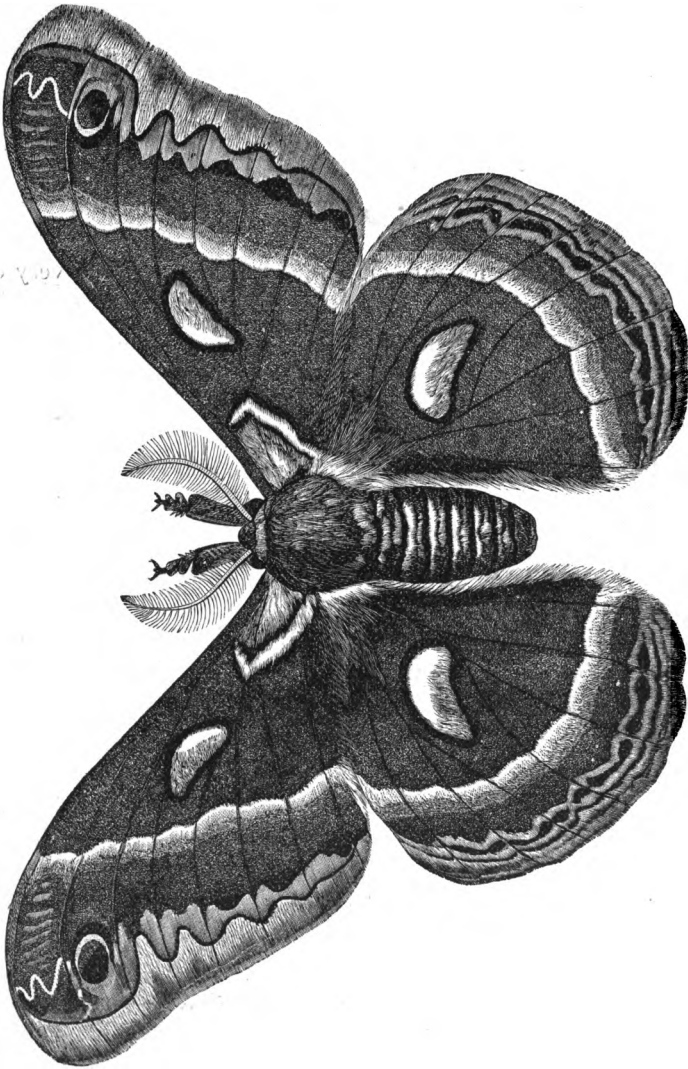


FIG. 1.—*Platyamnia cecropia*, male moth. [After Riley.]

“Ground color of the wings, grizzled dusky-brown with the hinder margins clay-yellow; near the middle of each of the wings there is an opaque kidney-shaped white spot, shaded more or less on the outside



with a dull red, and edged with black; a wavy dull red band, edged inside with white, crosses each of the wings, and the front wings next to the shoulders are dull red with a curved white and black band, and have near their tips an eye-like black spot with a bluish-white crescent; the upper side of the body and legs are dull red; the fore part of the thorax and the hinder edges of the rings of the abdomen are white, and the belly is checkered with red and white. There is considerable

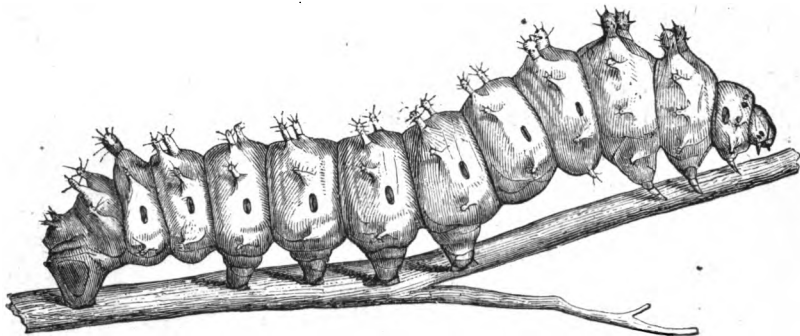


FIG. 2.—Mature larva of the Cecropia Moth. [After Riley.]

variation in the ground color of individuals, some being quite dark, and others quite light, but the female differs from the male in nothing but her larger abdomen and much smaller antennæ or feelers."

The cocoon, which is made of silk secreted by the larva, (Fig. 3) is a large affair of a dull dead grass or leaf color, becoming more and more faded as the season advances. It is usually fastened lengthwise upon a twig as shown in the illustration, but occasionally it is attached to fences, upon posts or along the lower edges of rails or boards. It is composed of two distinct layers, the outer one, a loose wrinkled irregular brown-paper like parchment, inclosing an inner oval cocoon. This latter is of the same kind of silk, but is woven more regularly and closely, and reminds one of the cocoon of the common silk-worm.

The chrysalis or pupa, which is brown, is well represented by the Figure 13, which is that of the Polyphemous Moth.

But a single generation of the insect occurs annually. It winters as a chrysalis, and only emerges as a moth after the leaves have started in May or early June. The sexes soon pair and the eggs are at once deposited in small patches upon the plants which are to serve as food for the larvæ. They are about 0.09 of an inch in length, sub-oval, somewhat flattened, and of a pale cream color, shaded with light-

brown. They hatch in about six to ten days. In treating of this insect, Professor C. V. Riley writes as follows: \* “The young worms differ so much from the mature ones, and undergo such great changes in appearance in the course of their lives, that we are surprised that no account is to be found of these larval changes in any of our entomological works. When first hatched they are entirely black, with the tubercles placed in the same position, but being larger at the base, and with a narrower stem than in the more mature individuals, the upper and smaller end being crowned with a whorl of conspicuous stiff black bristles. After the first moult, the body is of a deep orange color, with the tubercles and head black, and with longitudinal rows of black dots running between them. After the second moult, a still greater change takes place: the body acquires a beautiful yellowish-green tint, the tubercles on the back are blue on segments one, twelve and thirteen; coral red on two and three, and yellow, with black spines, and a black spot on the inner side and outside of the stem, on four to eleven. Those at the sides are blue, and the head is of the same color as body. After the third moult, the black spots, except a row below the stigmal row of tubercles, disappear; the tubercles themselves lose all black except the spines, and the head and body become delicate bluish-green, rather than yellowish-green as formerly. After the fourth and last moult, the red tubercles near the head frequently become yellow, and when full-grown, the worm measures over four inches and presents the appearance of Figure 2, the tubercles being respectively of the most delicate yellow and blue. Two weeks after the worm begins to spin it changes to a chrysalis, and as already stated, passes the winter in this form.”



FIG. 3.—Cocoon of *Platysamia cerropia*. [After Riley.]

\* American Entomologist, Vol. II, p. 100, 1870.

#### FOOD-PLANTS.

The larva of the *Cecropia* moth is not confined to any particular food-plant, but is quite a general feeder. It lives equally well upon the willow, plum, apple, elm, currant, barberry, elderberry, hazel, lilac, hickory, honey-locust, black-locust, red-root, blackberry, maple, elder, box-elder, cottonwood, poplar, mountain ash, catalpa, etc. Upon tree-claims, however, it appears to show a decided preference for the soft maple and box-elder, these two trees being often completely defoliated by the "immense" worms when they are present even in moderate numbers. So numerous has the insect been during the past few years in some of our frontier counties that the cocoons could be gathered by the bushel from the bare twigs during winter. In Dakota, it is equally numerous and destructive. Professor I. H. Orcutt, in speaking of the abundance of this insect in Dakota during the past year, says: \* "The destruction has been so great in many places, it is feared that tree-raising must be abandoned if something is not done to check them."

If there was a possibility of deriving some benefit from this insect through the manufacture or sale of its cocoons for silk, we might feel more inclined to tolerate the injury to our trees. Up to the present time, however, no method has been discovered whereby the reeling of the silk can be profitably accomplished. Besides, were it possible for us to reel the silk at a cost no greater than for that of the ordinary silk-worm, its much coarser texture would render it much inferior to the silk now used.

#### NATURAL ENEMIES AND PARASITES.

Were it not that this large worm is kept in check by many natural enemies, such as birds and predaceous insects, as well as insect parasites, it would soon become much more numerous than it is now. The rate of increase possible is between 200 and 300 for each female. It can therefore be seen how quickly this insect alone could defoliate all the trees in the country. Even now, with the numerous checks upon its increase, it too often becomes a pest in different parts of the country. Especially is this true in newly settled prairie regions, where the introduction and cultivation of trees offer an abundant food supply for the insect in its larval stage. Here, too, the natural enemies of the in-

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\* Dakota Agricultural College and Experiment Station, Bulletin No. 13.

sect are less numerous for the first few years than they are later, and in timbered districts.

As common and well-known as is the *Cecropia* moth, some of its enemies, and especially its insect enemies, are scarcely known to exist save to entomologists. In this connection, therefore, some of the most important of the latter will be mentioned and figured. In doing this I cannot do better than to quote from the article already referred to above.

"THE LONG-TAILED OPHION. (*Ophion macrurum* Linn.)—This large yellowish-brown Ichneumon fly (Fig. 4) is often bred from the cocoons, in place of the moth which one expects. It is one of the most common parasites of this large insect, and the females appear to be altogether more common than the males, for we have bred no less than seven of the former, and not a single one of the latter sex. The female, according to Mr. Trouvelot, deposits from eight to ten eggs upon the skin of her victim, and the young larvæ soon hatch from them and commence to prey upon the fatty

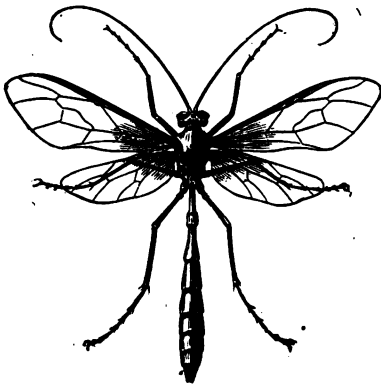


FIG. 4.—The Long-tailed Ophion (*Ophion macrurum*). [After Riley.]

parts of the worm. But as only one of the parasitic larvæ can find food sufficient to mature, the rest all die from hunger, or else are devoured by the strongest one which survives them. At first one would suppose that this disposition of several eggs by the parent Ichneumon, where only a single larva can develop, is a striking instance of misdirected instinct; but we find similar prodigality throughout nature, for every individual is so subject to disasters of one kind or another in its struggle for existence, that a provision of several ova is often necessary to insure the future development of a single one, just as we often sow several seeds of some particular plant in order to insure the growth of a single one.

"After the *Cecropia* worm has formed its cocoon, the parasitic larva, which had hitherto fed on the fatty portions of its victim, now attacks the vital parts, and when nothing but the empty skin of the worm is left, spins its own cocoon, which is oblong-oval, dark brown inclining

to bronze, and spun so closely and compactly that the inner layers, when separated, have the appearance of gold-beater's skin. If we cut open one of these cocoons soon after it is completed, we shall find inside a large fat legless grub (Fig. 5), which sometimes undergoes its transformations and issues as a fly in the fall, but more generally waits till the following spring."

Here in the West, as also in portions of the East, another Ichneumon fly infests the *Cecropia* worm. This latter species of parasite is exceedingly numerous, and as a rule must infest fully one-half of all the larvæ that mature to spin cocoons. It is the *Cryptus nuncius* of Say, and is shown herewith (Fig. 6). This parasite is black and red, with the eighth, ninth and tenth joints of the antennæ white; the legs are red, with the posterior tibiæ black. The first four abdominal joints red, the remainder black, also the sheaths of the ovipositor of the same color. Wings transparent. After the *Cecropia* larva has completed its cocoon, the numerous larvæ of the parasite become fully fed, and spin their own thin parchment-like cocoons within that of their host, which has entirely disappeared by this time. So numerous are these parasites, that they usually completely fill the cocoon. Figure 7 shows one of the infested silk-worm cocoons as it appears when cut in two crosswise. It is a regular honey comb in appearance. The flies remain in the cocoons over winter and issue the following June. Herewith is appended a more complete description of the above named Ichneumon:

**FEMALE.**—"Black, shining, somewhat robust; head short and broad; antennæ as long as the body, slender, black, the seventh to twelfth joints white or dirty yellow, the third and fourth joints long, the third rather longest, fifth a little shorter than the fourth, and the sixth about half as long as the third. Palpi black, or only white at joints (female), white or a little clouded in the male. Thorax finely punctured, the dorsal lines rather deep; scutellum subconvex, polished; metathorax finely scabrous, opaque, its base smoother and shining, the elevated lines tolerably well

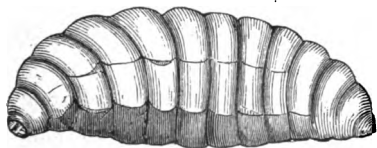


FIG. 5.—Larva of the Long-tailed Ophion. [After Riley.]

defined, forming a large, more or less distinct, subrhomboidal central area, lateral tubercles not well defined. Wings faintly tinged with fuscous; nervures and stigma blackish, pale at base; areolet large, subquadrate. Legs pale rufous, the front coxæ black, the posterior femora and tibiæ at tips, and the base and apex of their tarsi blackish, rest of tarsi white. Abdomen

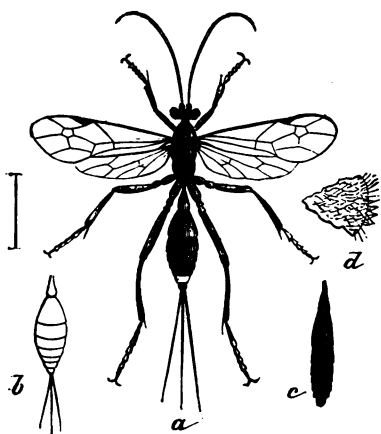


FIG. 6.—The *Cecropia Cryptus* (*Cryptus nuncius*: a, female fly; b, abdomen of *C. samia*; c, male abdomen. [After Riley.]

rather stout (female), or moderately slender (male), subovate in the female, in the male as at c in the figure (Fig. 6), polished, rufous or yellowish-rufous; basal segment strongly arcuated, broad at tip; the fourth joint at tip and following joints black, the sixth or seventh, or both, more or less white above; ovipositor nearly or quite as long as the abdomen, rufous, valves black. Length 8—11mm; expanse of wings 12—19mm.

MALE.—In addition to the characters already given the male differs from the female in the absence of the white spot at tip of abdomen; in having the entire lower edge of antennæ rufous, while above they have the light color yellowish instead of white.

A third Hymenopterous parasite of the *Cecropia* larva is shown here (Fig. 8). It is the insect that Professor Riley has called *Chalcis marix*, and concerning which he writes as follows in the American Entomologist, Vol. II, pp. 101–2:

“In May, 1869, we received from Mr. V. T. Chambers, of Covington, Kentucky, numerous specimens of the hitherto undescribed beautiful large *Chalcis* fly figured herewith (Fig. 8), which he had taken from the cocoon of the *Polyphemus* moth, which is quite common, and issues as early as the middle of February in that locality. He says, I was satisfied that the cocoon did not contain a living *Polyphemus* and therefore opened it. It contained so little besides these insects and their exuvix, as to suggest strongly the old idea that the caterpillar had been metamorphosed into them (as in a sense it had). There were forty-seven of

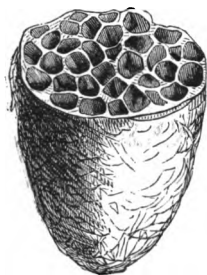


FIG. 7.—Transverse section of *Cecropia* cocoon, showing cocoons of the *Cryptus* fly. [After Riley.]

them, of which twenty-three were females. As all the males, and some of the females, were dead when I opened the cocoon, I think it likely that the former never do emerge, and perhaps but few of the latter; otherwise *Polyphemus* would soon be exterminated.

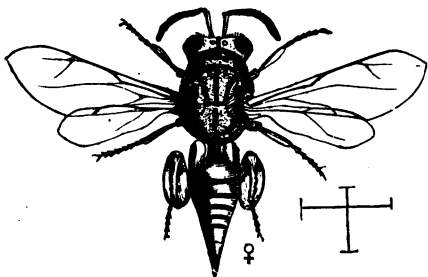


FIG. 8.—The Mary Chalcis fly (*Chalcis marizæ*), female. [After Riley.]

they can much more easily escape. \* \* \* The same fly also attacks the *Promethia* worm—another of our large native silk-worms—and Mrs. Treat has had a similar experience with Mr. Chambers, of finding them dead in its cocoon. She has upon two occasions found cocoons with a dead *Chalcis* fly fast in the hole which it had eaten to make its escape, and upon cutting open such cocoons they were found literally packed with dead *Chalcis* flies. It would seem that they all make their escape through the hole made by some one of their number, and that if this particular one fails in the undertaking, they all perish rather than make holes for themselves.”

This beautiful large *Chalcis* fly also occurs here in the west, where it is not at all rare, though I have only once bred it from the cocoon of the *Cecropia* moth. In color it is yellow, marked with black as shown in the illustration. The original description is given below for the benefit of those who care to use it.

**CHALCIS MARIZÆ** Riley.—Female, yellow, beautifully marked with black. *Head*, yellow, with an arcuate black mark behind base of the antennæ, connected with a fine short longitudinal black line leading to lower ocellus, and from thence to posterior margin of occiput which is margined with black; prothorax with a medium black dot. *Antennæ*, (Scape + nine joints) ten jointed; scape fulvous with superior edge black, flagellum dark brown or black. *Thorax* with large shallow close-set punctures; mesothorax somewhat striated transversely, trilinear with black, the three lines connected by a transverse line which separates the prothorax from mesothorax, the middle line straight, the outer ones deeply impressed, approaching behind and connected on the posterior margin by a short transverse line, and then suddenly diverging on lateral suture of scutellum; a longitudinal black dot on each side over tegulæ; scutellum edged anteriorly with black and with a central longitudinal black line; basal margin of metathorax, with a spot on each extreme side and a large subtriangular mark on disk, black; pleuræ with two black lines on each side. *Wings* hyaline. *Abdomen* yellow with sometimes a faint



tinge of green, black at base and tip, and each segment branded with black superiorly; petiole yellow, black at tip above. Legs yellow, the tarsi inclining to fulvous; a broad line on posterior coxæ above, and interior edge of femora and tibiæ, and tip of femora, black; the femora about as large as abdomen with over twelve minute black spines on inferior edge. Average length 0.20 inch (10mm).

"Male differs in the less pointed abdomen, and somewhat longer petiole, in the scape of antennæ not being black superiorly and being much more robust; in the flagellum being of the same color as scape, and in coxæ having a black line both above and beneath. Average length 0.15 inch. Described from ten males four females bred from *Attacus polyphemus* and two males one female from *A. promethea*. Variable in size, some males being much larger than some females."

Besides the three species of Hymenopterous parasites just described, there are still others of a similar nature that attack the *Cecropia* worm as well as others of our large native silk-worms. Each of these parasites does much towards keeping them from becoming more than ordinarily common. Then, too, we are aided in our warfare against the larvæ of this and various other large moths by several species of



FIG. 9.—Tachina Fly. [After Walsh.]

Tachina or Flesh flies. These flies, as a rule, are somewhat larger than the common house fly, and have the general appearance of that shown in Figure 9. They deposit their eggs upon the back of the caterpillars, which they choose for victims, usually placing them just back of the head so that they cannot be scraped off. When these eggs hatch the young maggots enter the body of their host and live upon its internal tissues until they have become full fed, when they either abandon the caterpillar and enter the ground or else transform within its chrysalis to issue the following year as flies. These in turn seek other caterpillars on which to deposit their eggs, thereby keeping up the cycle of life as far as they are individually concerned in this grand struggle for a place among the living. Of course none of the worms that have been attacked by these Tachina flies ever become moths.

In addition to the enemies of the *Cecropia* worm already mentioned, we must not forget the fact that it is also frequently subject to diseases of a fungoid nature, as well as those due to bacteria.

## ARTIFICIAL REMEDIES.

Occasionally, through the failure of the natural checks, it becomes necessary for us to resort to some artificial measure for preventing this insect from injuring our trees. When this is the case, hand picking, or the use of insecticides, will prove very efficient. Hand picking can be carried on in two ways against this insect, viz., against the larvæ in summer, and against the pupæ during fall, winter and early spring. Professor I. H. Orcutt, of the South Dakota Agricultural College and Experiment Station, gives the subject some attention in Bulletin No. 13 of that institution for April, 1889. He writes:

“As the cocoons of these insects are conspicuous objects on the trees for half of the year, it does not seem necessary to enter into any lengthy discussion regarding the destruction of the worms. If the cocoons are collected in a given locality there will be no worms the following season. The cocoons may be torn down from the tops of the larger trees with a hook fastened to a pole. By opening a number of cocoons and carefully comparing the weight of those containing healthy paupæ with those which do not, it is not difficult to assort them. ONLY those containing healthy pupæ should be destroyed, as the others contain the pupæ of one of the *Cecropia*’s greatest enemies, and the farmer’s faithful friend. Cocoons may be kept in boxes (on shelves if many are to be preserved) with one-half inch holes bored in them. The holes will not allow mice to enter, but will allow small insects to escape. If the cocoons have not been assorted moths will appear about the first of June [earlier farther south], which may be taken out and destroyed. The friendly insects may not appear until several weeks after the moths have been destroyed. If the cocoons are carefully gathered and cared for as stated above, the relative number of the parasitic insects to the number of *Cecropia* larvæ will be greatly increased, as few cocoons need be overlooked in gathering. This will enable the small insect friends to almost annihilate the large enemies. If the worms are not numerous, they may be picked off and destroyed. One man writes that he cut about 12,000 in two with shears last summer [1888]. They may be destroyed, without being handled, by pouring a few drops of kerosene along the back from a can with very small nozzle. If the trees are large the can may be fastened to a pole at an angle, and be used by the person standing some

distance from the tree. If but few trees are to be protected, this seems to be by far the better way to proceed. Use but few drops of kerosene on each worm, as it will kill the leaves if poured on them."

If arsenical poisons, such as the London purple and Paris green are to be used, these should be stirred into water and sprayed upon the foliage by the aid of some good force pump and spray nozzle. Care should be taken in the use of these poisons so as not to have the solution or mixture too strong, otherwise there is danger of injuring the trees. Neither should the operator stand in the spray too much. It is always best to have the wind blowing from one when using these poisons. Then, too, there should be some caution taken with regard to stock when using these arsenical insecticides.\*

## THE POLYPHEMUS SILK-WORM.

(*Antheraea polyphemus* Linn.)

Next to the Cecropia worm just described, the Polyphemus silk-worm is one that attracts the attention of the general public quite often. Especially is this insect brought to the notice of those who plant and try to grow trees, whether for shade in towns and cities, or for groves upon homesteads and tree claims. This silk-worm is also one of the first insect enemies to show itself upon the high prairies where trees are planted. Like the Cecropia it is a very general feeder, and lives in moderate numbers from year to year upon such dwarf trees as occur scattered over the prairies of the region. Being a rapid multiplier like all other insects, the introduction of a plentiful supply of food soon has the effect of producing a host of the silkworms. The moth of the Polyphemus worm is smaller and plainer looking than that of the Cecropia, while the larva is shorter and more compactly built than that of the Cecropia moth. The larvæ feed upon the maple, box-elder, oak, walnut, hickory, basswood, elm, hazel, apple, quince, rose, thorn, plum, choke-cherry, sand-cherry, sycamore, poplar, birch, honey locust, black locust, blueberry, willow, etc.

"The eggs of Polyphemus are deposited singly, or in twos or threes, on the under side of a leaf or twig. \* \* \* They are of about the

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\* For the proportions of these poisons best to be used, see page 138 in the Appendix.

same size as those of *Cecropia*, less oval—the lateral circumference being nearly cylindrical—and more flattened. They are whitish, inclining to flesh color on the top and bottom, and encircled on the sides by a characteristic broad band of amber-brown, which is the natural coloring of the egg-shell and distinct from the brown fluid which is secreted with and fastens them to whatever object they are consigned. This brown band has a narrow pale spot at the two smaller ends. The moths issue with us [St. Louis, Missouri,] the latter part of April, or in May, and the female commences depositing very soon afterwards. The eggs hatch in about ten days afterwards.” Farther north the time for appearance is somewhat later, and of course varies with the season. If the latter is late the moths are delayed in their appearance.

The larvæ are described as follows by Professor C. V. Riley, in his fourth Missouri Report, which we have already quoted from above:\*

“**LARVAL CHANGES.**—In the first stage the larva is yellow, becoming greener in appearance as it increases in size. The tubercles are situated as in the other species and are yellow, capped with a whorl of rufous bristles. The two dorsal rows are large, conspicuous, and except on joint 11 uniform in size. In the subdorsal row they are large on the thoracic and twelfth joints, but almost obsolete on the rest. In the stigmatal row they are small and of equal size. Each joint has two transverse black lines between the subdorsal and the stigmatal rows of tubercles: the head is reddish-brown, and there is a transverse line of the same color on the first joint. In the second stage it is of a beautiful green; the tubercles are of the same relative size, those on the back having a length one-fourth the diameter of the body; they are thick and slightly bell-shaped, green at base, yellow in the middle, and orange-red at tip, with the bristles or spines mostly black. Only one of the black lines remains to each joint and that is very faint, contains the spiracles, and is shaded with paler green behind. The head and cervical shields are of a deeper red-brown and the anal plate is edged with pearly whitish-green. In the third stage there is little change: the tips of the tubercles deepen into coral-red; the subdorsal row becomes almost as conspicuous as the stigmatal, and there is no longer any black lines between them, though the spiracles are now quite black and well relieved by pale green behind. In the fourth stage the tubercles are relatively smaller, the head is of a still deeper purple-brown, with the front edge of first joint, and the lateral oblique line, which is now more distinct, of a delicate sulphur-yellow; the spiracles are deep brown, and the edge of the anal plate is silvery-white below, graduating into lilaceous and then into deep purple above. As it approaches the fourth moult, the tubercles acquire a metallic, or silvery cast, and the other colors deepen. In the fifth stage the seven oblique lines, connecting the subdorsal with the stigmatal tubercles on joints 5–11, are bright sulphur-yel-

\*Fourth Annual Report on the Noxious, Beneficial and Other Insects of the State of Missouri, 1872, pp. 125–9.

low, the tubercles appear tinselled and reflect golden, silver and purple hues; the dorsal rows give forth but two or three straw-colored bristles, and the subdorsal rows but one of the same color, all pointing upward and forward; while the stigmatal row produces one light and one dark one which point exactly in the

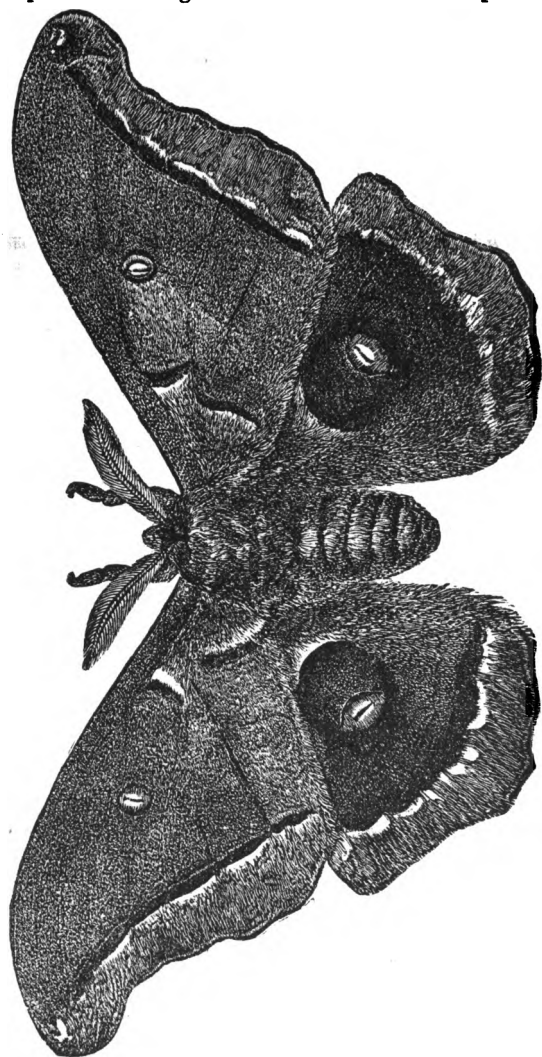


FIG. 10.—American Silk-worm (*Antheraea polyphemus*), male moth. [After Riley.]

opposite direction. Numerous other stiff hairs spring directly from the skin, especially below; the subventral thoracic tubercles are conspicuous; and there is a faint longitudinal central band. The front edge of the first joint is bright sulphur-yellow, with a soft retractile band of slate color between it and the head."

The cocoon, which is very closely woven, is composed of silk which when unwound has a glossy fibre. In form it is oval and equally closed at both ends; it is very dense and usually fastened to a leaf or leaves, with which it falls to the ground and lies among the fallen leaves during the fall and winter. Sometimes, however, the larva attaches its cocoon to twigs, where they hang exposed to the inclemencies of the weather and to the ravages of insect parasites. In the fabrication of this cocoon the larva mixes a cement composed of a gummy substance, which when it dries gives the cocoon a chalky appearance. This characteristic also renders the cocoon much more nearly parasite proof.

The natural history and habits of the Polyphemus silk-worm are very similar to those of the Cecropia worm, hence will not be dwelt upon here.

"The moth (Fig. 10) is of a dull ochre-yellow, shaded more or less distinctly with innumerable black particles and with a broad gray band along the front, or costal edge, and passing over the thorax. There is a darker, reddish-brown shade across the middle of the wings, and near this shade on each wing is a transparent eye-like spot, divided by a slender opaque line, and margined by a yellow and a black ring, the last much broader on the hind than on the front wings, being there

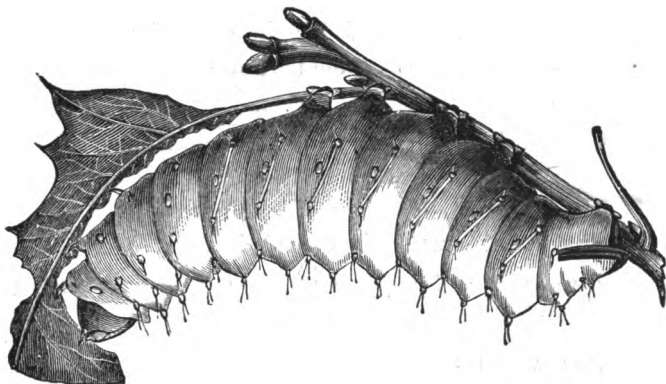


FIG. 11.—Larva of the American Silk-worm Moth (*Antheraea polyphemus*). [After Riley.]

widened on the inside into a large black spot, with the parts adjoining the eye-spot bluish-white. Near the hind margin of each wing is a dusky band (bluish on the front ones), edged with pink-white behind; and near the base of the front wings is a zig-zag crimson line,

edged inside with white. There is a great variation in the colors of this insect, dependent in some measure no doubt on the food of the larva; and it is a wonder that some of them have not been described

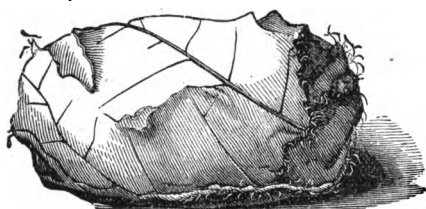


FIG. 12.—Cocoon of American Silk-worm.  
[After Riley.]

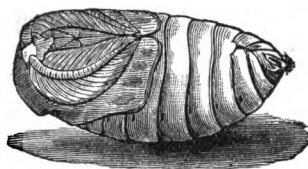


FIG. 13.—Chrysalis of American Silk-worm  
[After Riley.]

as distinct species. \* \* \* Specimens occur which have the general tint, either very dark or very pale; either brown, smoky-yellow, cream color, rust-red or greenish; while the large black spot on the hind wings is sometimes replaced by rust-red.”

The insect is sometimes double brooded in the more southern portions of the United States; but here in the North only a single brood of the worms is reared annually.

#### REMEDIES AND ENEMIES.

When the Polyphemus silk-worm becomes excessively numerous or sufficiently so to be injurious to the trees upon which it feeds, it can be treated in the manner directed for the Cecropia worm. It is also preyed upon by practically the same parasites as the former species.

In treating of these silk-worms I have confined my remarks to the economic feature aside from the possibility of their ever becoming of money value as silk producers. Much might be said on the latter feature of the subject. But, in a paper like the present, which is devoted to injurious insects, it is not to be expected that time will be spent in showing up the possibility of their being of money value.

#### THE APPLE-TREE TENT-CATERPILLAR.

(*Clisiocampa americana* Harr.)

Perhaps some of our eastern entomologists will be surprised at my inserting this well-known orchard pest among the insect defoliators of the trees grown upon tree-claims. If they do, they cannot be any more surprised than I was to learn of some of its peculiar freaks out



in the frontier counties of Nebraska while studying the insect life of that region. It was exceedingly common along the streams in Custer and adjoining counties, where the moth was observed during the first and second weeks of July flying about the scattered growths of small trees and about the farm houses. Both at Broken Bow and New Helena the moths were taken in the act of mating upon willows as well as in the thickets of plum and choke-cherry. Not only were the moths taken upon the willows, but dozens of their egg-clusters were also seen upon the twigs of these trees. Especially was this true at New Helena, upon the premises of Judge Matthews, where a short hedge of the white willow was growing. So very numerous were these egg clusters that more than a dozen of them were taken from a single tree less than eight feet in height. The remaining portion of the hedge, while perhaps less thickly studded with egg-clusters, contained them in much larger numbers than I had ever before seen them even upon such trees as the apple, peach, cherry, and plum. In one or two instances they had been deposited even upon the cottonwood.

In writing up this insect I can do no better than to quote the words of previous writers who have discussed it. Dr. William LeBaron wrote of it as follows:\*

"The eggs from which these caterpillars proceed [See Fig. 15 and 16, c] are deposited by the parent insect in the latter part of June, or the beginning of July, upon the smaller twigs, in oblong rings, each of which contains about two hundred and fifty eggs. These eggs are little thimble-shaped bodies, about one-twentieth of an inch in length. The young caterpillar, while in the egg, is bent double, the fold of the body being at the smaller end. The same degree of warmth which expands the buds of the apple tree also hatches the eggs, so that the young caterpillars are born in the midst of abundance. It sometimes happens, however, especially in the cold and wet springs of New England, that the growth of the leaves is arrested by an unfavorable change in the weather, after the young caterpillars are hatched. To meet this emergency, these little insects are endowed with the power of sustaining hunger for a considerable time. When wholly deprived of food, they will live from ten to twelve days. This species belongs to the tribe of Tent-making Caterpillars, and during the first two or three days of their existence they commence constructing a shelter for

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\* *American Entomologist*, Vol. II, pp. 143-6. [March, 1870.]

themselves by extending sheets of web across the nearest fork in the twig upon which they were hatched. As they increase in size they construct additional layers over those previously made, attaching them to the neighboring twigs, and leaving space enough between them for the caterpillars to pass. The shape of the tent is necessarily very irregular, depending upon the situation of the branches upon which it is constructed. The holes through which the caterpillars enter are situated near the extremities or angles of the nest. This nest when completed is about eight or ten inches in diameter. The caterpillars retreat into it at night and in stormy weather, and at other times when they are not feeding. The silken threads of which the web is composed are drawn from the body of the insect through a minute aperture situated behind the mouth, which is the outlet of two convoluted tubes, into which the ductile matter is secreted from which the silk is made. When going out to feed, the caterpillars always travel upon the upper side of the branches, and each one leaves a thread of silk behind it, which probably serves as a clue to direct it back to the nest. The silken trails thus formed are at first scarcely noticeable, but become very obvious after a branch has been traveled upon for a considerable time. Thus the caterpillar not only lives in a silken house, but covers its roads with a silken carpet. Like other larvæ, they shed their skins four times before arriving at maturity. When fully grown they are about one inch and three-quarters in length. \* \* \*

“The active period of this caterpillar, that is, the time from their hatching to their changing into chrysalids, is from five to six weeks, and when we consider their voracious appetites and that there are about two hundred and fifty individuals in each nest, we can easily form an idea of the extent of their ravages. Where there happens to be several nests on one tree, or where the tree itself is small, they often strip it of every vestige of foliage; and in neglected localities whole orchards are sometimes seen as bare of foliage on the first of June as in mid-winter. It is at about this date that the caterpillars cease their ravages, and the trees subsequently make an effort to recover, and do actually throw out a new set of leaves, but their fruitfulness for the season is destroyed, and the tree itself must have received a severe shock to its constitution.

“After five or six weeks of voracious feeding, the caterpillars arrive at maturity, and then leave the trees, and are to be seen crawling

in all directions upon the neighboring fences or other objects, in search of some suitable place in which to undergo their transformation into pupæ. They usually select some crevice or angle where they can get an attachment for their cocoons in two directions. Their favorite place is in the angle formed by the projection of the cap-board of fences or posts. In these positions they sometimes congregate so as to lie one upon the other. When about to construct its cocoon, the insect attaches itself by its hindermost feet, so as to leave the anterior part of its body free for motion; then in extending its body it draws some disconnected lines across from one side of the angle to the other, to serve as outlines or stays. Then, working down nearer home, it draws its lines more densely, so that near its body they constitute a pretty close texture, like a piece of loosely woven cloth, through which, however, the insect can be seen. When the web is finished, the insect emits a yellow fluid, with which it besmears the inside of the cocoon, and thus effectually conceals itself from view. [See Fig. 16, *d.*] This species remains in the chrysalis state about twenty days."

Here in the west the caterpillars of this moth do not have the advantages of their eastern relatives when it comes spinning time. Still, they are none the less plentiful even on the prairies, far away from the shelter of groves and thickets. During my wanderings over these regions at various times, I have seen hundreds of their bright yellow silken cocoons scattered about among the



FIG. 14.—The Apple-tree Tent-caterpillar (*Climacampa americana*), female moth. [After Riley.]

grass and low vegetation upon hillsides. In these instances they are attached to various things, as blades of grass, the stems of weeds and other low-growing herbs. Some of them are even hidden away under heaps of decaying twigs and leaves from the plants upon which the larvæ fed.

#### FOOD PLANTS.

The food-plants of this insect upon the prairies are the Sand-cherry, Red-root or "Jersey tea," and the dwarf willow (*Salix humilis*), all of which are quite generally distributed over the region lying within the tree-claim belt to the westward of the 97° of west longi-



FIG. 15.—Eggs of Apple-tree Tent-caterpillar. [After Riley.]

tude. These, too, form the chief growth of native "timber" over regions many square miles in extent—they comprise the "forests" of the region in question.

The American or Apple-tree Tent-caterpillar, while showing a preference for the trees belonging to the order Rosaceæ, is not entirely confined to these as its food-plants. It is also known to feed upon the Red-root or New-Jersey Tea (*Ceanothus americanus*), and, as stated above, also upon the dwarf willow (*Salix humilis*), both in the vicinity of West Point, and in the Sand Hills. If we can judge of its food-plants by the location of the eggs, it also feeds upon other willows and even upon the cottonwood on rare occasions. Now, that the insect has shown us that it is not necessarily confined to a few kinds of trees for its food, we have reason to fear that it will also become accustomed to still other food-plants. Hence the need for precaution against the increase and spread. If we include all the food-plants of this insect that have been named by different entomologists, we will certainly have a long list.

#### REMEDIES.

The tent caterpillars are among the most easily to be dealt with insect pests that we have. This is due to their habit of always living in communities within large and unsightly webs, that can be seen long distances. In the present instance the warfare is made doubly easy on account of the prominence of the egg masses also. These (Figs. 15 and 16, c) remain upon the twigs during summer, fall and winter, giving us all the opportunity and time that could be desired for their gathering and destruction. Those eggs

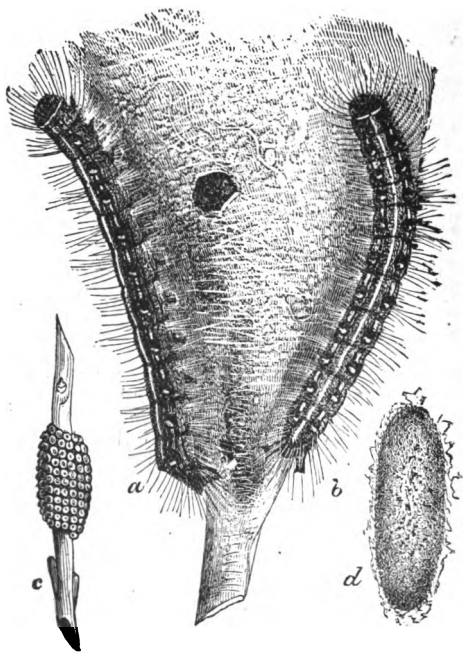


FIG. 16.—Apple-tree Tent-caterpillar: a and b, mature larvæ; c, twig with eggs; d, cocoon. [After Riley.]

that have escaped detection and destruction during all this time disclose caterpillars that at once begin the construction of webs, as if purposely to attract us to where the enemy is lurking. These webs along with their inhabitants can easily be destroyed either by the use of a torch or crushing. The larvæ when seeking spinning places, as well as the chrysalids within their cocoons, can likewise be destroyed.

#### NATURAL ENEMIES.

This insect has a large number of vertebrate and invertebrate enemies, taking the country over. These usually keep the pest within bounds; but when these fail to act from various causes, the white tents of the caterpillar soon appear upon the trees in large numbers.

The eggs are destroyed by a small hymenopterous insect, of which Professor F. L. Harvey, of the Maine Agricultural Experiment station, says, he reared "nearly seventy-five" from a single cluster.\* This insect is very likely a representative of the extensive family Chalcididæ, most of the members of which are known to be parasitic upon other insects. In figures 17 and 18 are shown two more of these hymenopterous parasites that destroy many of the larvæ of this and other caterpillars. These latter species deposit their eggs within the bodies of the caterpillars; where they hatch and remain as footless grubs, feeding upon



FIG. 17.—The Banded-legged Pimpla (*Pimpla annulipes*)—enlarged. [After Riley.]

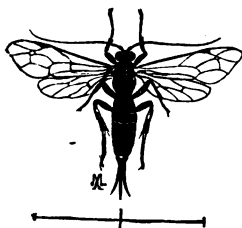


FIG. 18.—*Pimpla conquisitor*. [After Riley.]



FIG. 19.—The Fiery Calosoma (*Calosoma calidum*). [After Riley.]

\* Annual Report for 1888, p. 162.

the tissues of their host through its transformation to the chrysalid. In this latter they become full-fed and themselves change to the pupa stage to issue instead of the moth. One or more of the Flesh flies, Figs. 9 and 34, also destroy this insect in its caterpillar stage. Besides these, several of the larger Carabids or ground beetles are

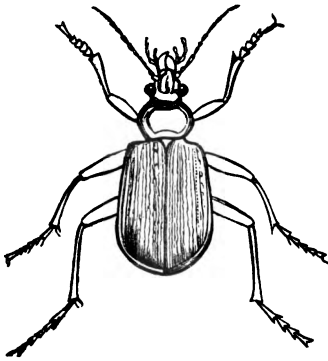


FIG. 20.—Green Caterpillar-hunter (*Calosoma scrutator*). [After Riley.]



FIG. 21.—Spined Soldier-bug (*Podisus spinosus*). [After Riley.]

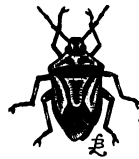


FIG. 22.—The Pictured Soldier-bug (*Perillus claudus*). [Original.]

known to feed upon the caterpillars, as do some of the true bugs. Two of these bugs are shown at Figs. 21 and 22, while at Figs. 19 and 20 can be seen illustrations of two ground beetles. Dr. LeBaron in the article already largely quoted, in speaking of the enemies of this insect, has the following to say: "The insectivorous birds generally reject the hairy caterpillars, and therefore we get but little help from them in the extermination of the present species. The Baltimore Oriole, or Golden Robin, is sometimes seen picking at their nests [tents], but they do not make them a common article of diet. The only birds that I know which devour them greedily are the American Cuckoos [both the black and yellow billed species]. Mr. Nutall, the ornithologist, speaking of the former species, says he has known them to make their chief diet, both for themselves and their young, of the Tent-caterpillar. But these birds are not numerous enough to effect much in checking the spread of this prevalent insect."

While all of these beneficial insects and birds mentioned above occur in the Eastern States and the older settled portions of this and adjoining states, but few or none of them are to be met with far out upon the prairies. The necessity, therefore, for prompt and active artificial remedies can at once be seen.

The following descriptions of the Apple-tree Tent-caterpillar are given for the benefit of persons who wish to read and compare them with the insect in its different stages of growth:

*Eggs*.—"The eggs are of a short cylindrical form with abruptly rounded ends. They are about 0.04 in. long and two-thirds as broad. The shell is of a very tough leathery texture, and of an ash-gray or white color, the inside having a bluish tinge, somewhat resembling that of mother-of-pearl. The eggs are placed perpendicularly upon the twig, to which they are firmly glued, the lower end being indented to give it a more secure attachment to the bark. They are also arranged side by side somewhat symmetrically in rows, their sides being slightly indented or moulded to each other and firmly glued together in one mass. Those eggs which are at the ends or margin of the mass are placed in an inclined position and the outermost ones are laid horizontally upon the bark, in order to produce a gradual slope from the surface of the mass to that of the bark.

"The eggs are covered over with a thick coating of glutinous matter, which entirely hides them from view and protects them from the weather. This matter is slightly transparent, and full of small air bubbles, giving its surface the appearance of net work. Its color varies from black to pale, but it is commonly darker than the bark, and its outer surface is smooth and shining as though coated with varnish.

\* \* \* \* \*

*Larva*.—"The larvæ when they first come from the eggs are 0.08 in. long, slightly tapering, of a black color, the under side and legs pallid, and they are slightly clothed with soft gray hairs. After they commence feeding they show a pale ring at each of the joints, and a faint pale stripe lengthwise along the back upon each side of its middle, and another low down upon each side. The head is deep black and some deep black dots may be discovered upon the body, from which the hairs arise. When they are a few days old and before the first moulting, they have increased to double their original size, and show some ash-gray or whitish lines, more or less distinctly, running lengthwise upon the back and sides.

"After the first moult it is 0.20 long, of a dark gray color with two ashy-white lines along the back and two along each side, the space above the upper lateral line having a large blackish spot on each segment. The hind edges of the segments and the under side of the body is also pale ash-gray, the head velvety black, and the body is clothed with numerous ash-gray hairs of different lengths.

"After the second moult it is half an inch in length, and nearly cylindric, the head being scarcely any broader than the body. It is now black and hairy, the neck with numerous long hairs directed forward and overhanging the head, which is velvety black. A broad dull blue stripe extends along the back and a narrower wavy brighter blue one along each side, with several short curved blue lines between them.

"After the third moult it has reached three-fourths of an inch in length, with yellowish-white hairs, and stripes, etc., much the same as before.

"After the fourth moult it is about an inch long, of a velvet black color with numerous yellowish or fox-colored hairs, with a white stripe down the back and numerous short crinkled white lines on the back and sides; a large black spot on each side of each segment, in the hind part of which spot is a transverse oval pale blue spot



having an impressed line across it; a second pale blue spot in the crinkled white lines below the black spot.

"The full-grown caterpillar is about two inches long and over a quarter of an inch thick, cylindrical, sixteen footed, and thinly clothed with fine soft yellowish or fox-colored hairs of different lengths, the longest ones measuring a quarter of an inch. These hairs are rather more numerous upon the neck, where they project obliquely forwards, shielding in some measure the head, which is black and furnished with shortish black hairs. The body is of a deep black color. A white stripe extends along the back its entire length, commencing upon the second or the base of the first segment back of the head. In this stripe are numerous minute black dots. On each side of it are a number of short crinkled irregular longitudinal lines, of a yellow color, which become paler down upon the sides. Above the lowermost series of these lines is a row of transverse oval pale blue spots, one upon the middle of each segment. On the anterior side of each of these spots is a broader deep velvety black spot, as it appears to the naked eye, forward of which is a rather faint pale blue oblong spot or short stripe, reaching to the anterior margin of the segment. Lower down, the sides are mottled with the same tint of pale blue coloring, interspersed with short crinkled pale yellow or whitish lines. The under sides of the body and the legs are black, the soles of the prolegs white. The neck or anterior edge of the segment next to the head is also white, with two small somewhat square yellow spots above.

"The *moths*, male and female [Fig. 14], are of a dull reddish or fox-color, different individuals varying in the depth of their coloring, the females being often paler, approaching to grayish, and the males often darker, sometimes brown with scarcely any tinge of red. The mark by which this species is most readily distinguished is two straight white stripes which extend obliquely across the fore wings, parallel to each other and to the hind margin, dividing the wing into three nearly equal portions. The anterior stripe is often slightly broader than the posterior one, especially towards the outer margin of the wing. In some females these stripes are placed nearer to each other; and though commonly parallel, in some instances from the middle of the wing to the outer margin, or even through their entire length, they diverge from each other. In the males they are less variable, but the space between them in this sex is frequently pale gray, and there are also numerous gray hairs on the basal portion, and a few towards the apical margin also. The hind wings are of the same color as the anterior ones, but without any pale marks. On their under sides the wings are the same color as above, and commonly a white band extends across both pairs near their middle, that on the fore wings being straight and widened at its outer end, that on the hind wings broader and curved. The fringe on the fore wings has a white alternation near the outer angle and another broader one on the middle; along the inner angle and on the hind wings it is white, slightly varied in places with dull reddish. These colors of the fringe are much more distinct in the darker colored varieties of the male. The hairs with which the thorax is densely coated are often grayish. The stalk of the antenna is dull white and its branches are dark rusty red, sometimes with a whitish line on their outer side. The feet are white or yellowish white, particularly in the males. The wings when spread measure from 1.20 to 1.30 in the males, and in the females from 1.40 to two inches."

## THE FOREST-TREE TENT-CATERPILLAR.

(Clisiocampa sylvatica Harr.)

Although not as common an insect away from the timbered portions of the Missouri river and its tributaries as is the species just described, this second Tent-caterpillar also occasionally defoliates the trees growing upon newly improved lands. In order that this latter species may be distinguished from the former, a short sketch of it is given below. The caterpillars, besides feeding upon many of the trees and plants comprised in the bill of fare of *americana*, also destroy the foliage of a number of forest trees. Some of these are not planted upon tree-claims, as for example the oaks; but occasional groves of them and other hard-wood trees grow along the larger streams in the region. These form centers of distribution for the insect from which it is spread over the country. While not nearly so common as *americana*, the *sylvatica* is quite frequently met with both in the mature and caterpillar stages even upon the prairies several miles away from the natural groves.



FIG. 23.—The Forest Tent-caterpillar: a, eggs; b, female moth; c, magnified upper view of egg; d, same, side view. [After Riley.]



FIG. 24.—Larva of Forest Tent-caterpillar. [After Saunders.]

The natural history of the Forest caterpillar is given briefly as follows in the *American Entomologist*, Vol. II, pp. 261-6: "The egg-mass from which the Tent-caterpillar of the Forest hatches (Fig. 23, a, showing it after the young larvæ have escaped) may at once be distinguished from that of the common Tent-caterpillar by its being of a uniform diameter, and docked off squarely at each end. It is usually composed of about 400 eggs, the number in five masses which we counted ranging from 380 to 416. Each of the eggs composing

this mass is of a cream-white color, 0.04 inch long and 0.025 inch wide, narrow and rounded at the attached end or base, gradually enlarging towards the top, where it becomes slightly smaller (Fig. 23, *d*), and abruptly terminates with a prominent circular rim on the outside, and a sunken spot in the center (*c*). These eggs are deposited in circles, the female moth stationing herself, for this purpose, in a transverse position across the twig. With abdomen curved she gradually moves as the deposition goes on, and when one circle is completed she commences another—and not before. With each egg is secreted a brown varnish, which firmly fastens it to the twig and to its neighbor, and which, upon becoming dry, forms a carinated net-work of brown over the pale egg-shell. These eggs are so irregularly laid and so closely glued to each other, that the sides are often so appressed that the moth economizes space almost as effectually as does the Honey-bee in the formation of its hexagonal cells. \* \* \*

“The eggs are deposited in the latitude of St. Louis, during the latter part of June. The embryo develops during the hot summer weather, and the yet unborn larva is fully formed by the time winter comes on. They hatch with the first warm weather in spring—generally from the middle to the last of March—and though the buds of their food-plant may not have opened at the time, and though it may freeze severely afterwards, yet these little creatures are wonderfully hardy, and can fast for three whole weeks, if need be, and withstand any amount of inclement weather. The very moment these little larvæ are born, they commence spinning a web wherever they go. At this time they are black with pale hairs, and are always found either huddled together or traveling in file along the silken paths which they form when in search of food. In about two weeks from the time they commence feeding they go through their first moult, having first grown paler or of a light yellowish-brown, with the extremities rather darker than the middle of the body, with the little warts which give rise to the hairs quite distinct, and a conspicuous dark interrupted line each side of the back. After the first moult, they are characterized principally by two pale yellowish sub-dorsal lines, which border what was before the dark line above described. After the second moult, which takes place in about a week from the first, the characteristic pale spots on the back appear, the upper pale line becomes yellow, the lower one white, and the space between them

bluish ; indeed, the characters of the mature larva are from this period apparent. Very soon they undergo a third moult, after which the colors all become more distinct and fresh, the head and anal plate have a soft bluish velvety appearance, and the hairs seem more dense. After undergoing a fourth moult without material change in appearance, they acquire their full growth in about six weeks from the time of first feeding. At this time they appear as at Figure 24, and for those who are interested in such matters, we quote below Dr. Fitch's description of the full-grown larva, as it is the first accurate and detailed description that was published, and as we have occasion to refer to it further on.

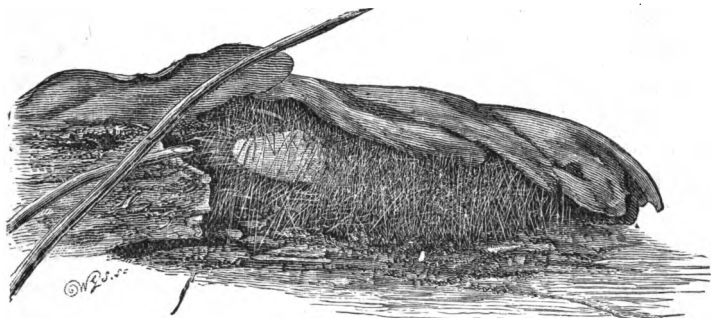


FIG. 25.—Cocoon of Forest Tent-caterpillar. [After Saunders.]

“At this stage of its growth the Tent-caterpillar of the Forest may be seen wandering singly over different trees, along roads, on the tops of fences, etc., in search of a suitable place to form its cocoon. It usually contents itself with folding a leaf or drawing several together for this purpose, though it frequently spins up under fence boards and in other sheltered situations. The cocoon is very much like that of the common Tent-caterpillar, being formed of a loose exterior covering of white silk with the hairs of the larva interwoven, and by a more compact oval inner pod that is made stiff by the meshes being filled with a thin yellowish paste from the mouth of the larva, which paste, when dried, gives the cocoon the appearance of being dusted with powdered sulphur. Three days after the cocoon is completed the caterpillar casts its skin for the last time and becomes a chrysalis of a reddish-brown color, slightly dusted with a pale powder, and densely clothed with short pale yellow hairs, which at the blunt and rounded extremity are somewhat larger and darker. In a couple of weeks

more, or during the forepart of June, the moths commence to issue, and fly about at night. This moth (Fig. 23, *b*) bears a close resemblance to that of the common Tent-caterpillar, being of a pale brownish-yellow or rusty brown, and having two oblique transverse lines across the front wings. It differs, however, in the color being paler or more yellowish, especially on the thorax; in the space between the oblique lines being usually darker instead of lighter than that on either side; but principally in the oblique lines themselves being dark instead of light, and in a transverse shade, often quite distinct, across the hind wings. As in *americana*, the male is smaller than the female, with the wings shorter and cut off more squarely. Considerable variation may be found in a given number of moths, but principally in the space between the oblique lines on the front wings being either of the same shade as the rest of the wing, or in its being much darker; but as we have found these variations in different individuals of the same brood, bred either from oak, hickory, apple and rose, they evidently have nothing to do with the food-plant. The scales on the wings are very loosely attached, and rub off so readily that good specimens of the moth are seldom captured at large."

#### FOOD-PLANTS.

The Forest-tree Tent-caterpillar will feed upon apple, rose, cherry, plum, poplar, ash, oak, hickory, walnut, peach, willow, etc. It therefore is capable of doing more injury upon the tree-claims than the common species, provided it can reconcile itself to the change of locality and surroundings as readily as does the other insect.

#### REMEDIES.

The remedies given for guarding against injury by the former species of Tent-caterpillar will apply equally to this insect, although its habits vary somewhat from those of that species. On account of the usual habitat of the present insect, artificial remedies cannot readily be employed, and we must depend upon our friends, the birds and predaceous insects, to do the good work for us. Professor Riley, in the article from which I have quoted, in speaking of remedies, has the following to say in reference to these:

"It is always wise to coöperate whenever we can with our little friends among the bugs, and it is consequently very necessary to be

acquainted with them. It happens, fortunately, that we have several which aid us in keeping the Tent-caterpillar of the Forest in check, and in the natural forest we must trust entirely to these auxiliaries, as the mechanical means that can profitably be employed in a moderate sized orchard are impracticable in broad extents of timber. Indeed, these cannibals and parasites do their work so effectually that this caterpillar is seldom exceedingly numerous for more than two successive years in one locality. It prevails suddenly in great numbers, and again is scarcely noticed for years, very much as is the case with the true Army-worm. Thus, after attracting such general attention in 1867 in many parts of the East, it has scarcely been noticed since. This is its history everywhere, and we may reasonably hope that in those parts of the West where it has been cutting such a figure the present summer [1870], it will suddenly be so subdued as not to be noticed for some years to come. Its undue increase but combines the assaults of its enemies, until they multiply so as to gain the ascendancy. Then, from insufficiency of food these enemies suddenly decrease in numbers, and their natural prey has a chance to increase again. And so it goes on in the 'struggle for life,' and in the great complicated net-work in which every animal organism is involved: a check here and a check there, and no one of all the myriad forms allowed to keep the ascendancy beyond a limited time. The most efficient cannibal insects in checking the increase of the Forest caterpillar are the larger ground beetles belonging to the genus *Colosoma*. These beetles will pounce upon the worms with astonishing greed, and are especially prone to attack them when helplessly collected together during the moulting periods. The rummaging Ground Beetle (*Colosoma scrutator*), which every one will recognize from the figure (20, page 30), is especially fond of them." The parasites mentioned in connection with the common Tent-caterpillar also attack and destroy the present species. One of the hymenopterous parasites of this moth is shown at Fig. 26.



FIG. 26.—*Pimpla pedalis*. [After Glover.]

For those who care to read a full description of the mature caterpillar, it is given below :

"The caterpillar, as seen after it has forsaken its nest and is wandering about, is an inch and a half long and 0.20 thick. It is cylindrical and of a pale blue

color, tinged low down on each side with greenish gray, and is everywhere sprinkled over with black points and dots. Along its back is a row of ten or eleven oval or diamond-shaped white spots, which are similarly sprinkled with black points and dots, and are placed one on the fore part of each segment. The intervening space is black, which color also forms a border surrounding each of the spots, and on each side is an elevated black dot, from which arises usually four long black hairs. The hind part of each segment is occupied by three crinkled and more or less interrupted pale orange-yellow lines, which are edged with black. And on each side is a continuous and somewhat broader stripe of the same yellow color, similarly edged on each of its sides with black. Lower down upon each side is a paler yellow or cream-colored stripe, the edges of which are more jagged and irregular than those of the one above it, and this stripe also is bordered with black, broadly and unevenly on its upper side, and very narrowly on its lower side. The back is clothed with numerous fine fox-colored hairs, and low down on each side are numerous coarser whitish ones. On the under side is a large oval black spot on each segment, except the anterior ones. The legs and prolegs are black and clothed with short whitish hairs. The head is of a dark bluish color freckled with numerous black dots and clothed with short blackish and fox-colored hairs. The second segment or neck is edged anteriorly with cream-white, which color is more broad upon the sides. The third and fourth segments have each a large black spot on each side. The instant it is immersed in spirits the blue color of this caterpillar vanishes and it becomes black."

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## THE FALL WEB-WORM.

(*Hyphantria cunea* Drury.)

Another insect against which the tree planter has to contend here in the West is the one known by the popular name of "Fall Web-worm," on account of its appearance at that season of the year. Like the several species already mentioned in this paper, it is also a member of the family Bombycidae, or silk spinners; and like them is a web maker. This insect is a very general feeder, and attacks indiscriminately both fruit and forest trees. Of course, as is the rule with most other injurious species, it has preferences for some food-plants, upon which it works much more severely than others. Among these latter, the box-elder and cottonwood stand at the head of the list.

In Dakota and northern Nebraska there is but a single brood of the worms annually; but southward there are two. In the neighborhood of Lincoln a single brood is the rule, but stray colonies of the caterpillars are sometimes seen during the month of June, thus showing that even at this latitude two broods are possible when the climatic conditions are favorable.

Unlike the Tent-caterpillars of the forest and orchard, which feed outside of their webs, this web-worm feeds entirely within its web, and when the foliage upon one limb has been devoured, the web is extended so as to inclose fresh food.

Professor Riley has described this insect so thoroughly and given its life-history so fully in the Annual Report of the United States Commissioner of Agriculture for the year 1886,\* that I will not attempt to do more than to mention a few of the leading points in its natural history and distribution.

The Fall Web-worm is primarily a forest insect that has been confined in its distribution to the wooded portions of the country, but which has recently become much more common and widely disseminated in portions of the West on account of the additions made to the tree covered areas. The many homes which have been established with their groves of young trees on the sea-like prairies, have formed so many harbors for different insects as they are being wafted over the country by the winds, that the wonder is how a single tree survives. The Web-worm, too, has changed its habit from that of a retiring nature to a social one. It has become partial to cities, towns, and farms that are more or less removed from the dense forests in which lurk its enemies.

#### NATURAL HISTORY.

The female moth (Fig. 30, *a*) deposits her eggs to the number of 400 to 500 in a cluster upon a leaf, either on the upper or lower surface. As with most other social caterpillars, the tender leaves near the end of a branch or twig are chosen by the parent moth for this purpose, so that the little larvæ when they first hatch will be provided with the tenderest and best of food. The eggs are of a bright golden-yellow color, quite globular, and ornamented with numerous regular pits that give them the appearance of a beautiful golden thimble under a magnifying glass. In diameter they measure 0.4<sup>mm</sup>. The clusters of eggs are interspersed with hair-like scales, as shown in the accompanying illustration (Fig. 30, *b*). As the time for hatching approaches, the golden-yellow color gives place to a dull leaden hue, due to the young larva within which is dark colored. The time between the deposition and the hatching of the eggs is dependent upon the weather, and of

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\* Pp. 518-539, Pls. X and XI.



course varies accordingly. If favorable, a week will suffice; while on the contrary, if inclement, ten days or two weeks may be required.

In computing the possible increase of this insect in a region where there are two broods annually Professor Riley says: "Without check the offspring of one female moth might in a single season (assuming one-half of her progeny to be female and barring all checks) number 125,000 caterpillars in early fall—enough to ruin the shade trees of many a fine street."

As soon as the young caterpillars hatch they begin to spin a web of silk for themselves, which by their united efforts soon becomes large enough to attract attention. "Under this protecting shelter they feed in company, at first devouring only the green upper portions of the leaf, and leaving the veins and lower skin unmolested. As they increase in size they enlarge their web by connecting it with the adjoining leaves and twigs; thus, as they gradually work downwards, their web becomes quite bulky, and as it is filled with brown and skeletonized leaves and other discolored matter as well as with their old skins, it becomes quite an unpleasant feature in our public thoroughfares and parks." On the farm and tree-claim these webs are equally unsightly, as they are also in the forest and along the tree-fringed water courses of the prairies.

As before stated, the Fall Web-worm always feeds within this web, which is enlarged from time to time as the food gives out and a new supply is needed. In about one month the caterpillars have attained their growth. Most of them now leave their web and begin wandering about in search of a suitable place in which to spin their slight cocoon and transform to chrysalids. The pupa, which is shown in Fig. 27 at *d* and *e* and 29 at *b*, is usually formed in some crevice of the bark or similar place above ground for the first or spring brood; but sometimes they are also formed inside of the larval webs. The larvæ of the second or wintering brood—the only one northward—however, usually enter the ground where the cocoon is formed just below the surface.

The pupa or chrysalis, which is 0.60 inch in length and a little less than a quarter of an inch broad in the middle, is of a very dark-brown color, and has the surface faintly punctate. The characteristic feature by which it is to be distinguished from other lepidopterous chrysalids is the swelling about the middle, shown best in Fig. 29, *b*.

## DESCRIPTIVE.

Since the eggs and pupa have already been characterized, they will not be redescribed here.

*Larva*.—[Fig. 27, *a, b, c*.]—When first hatched the little caterpillars are pale yellow with a black head, and are adorned with two rows of black marks along the body which is provided with but few hairs. They pass through several (four or five) moults, and when full grown generally appear pale yellowish or greenish, with a broad dusky stripe

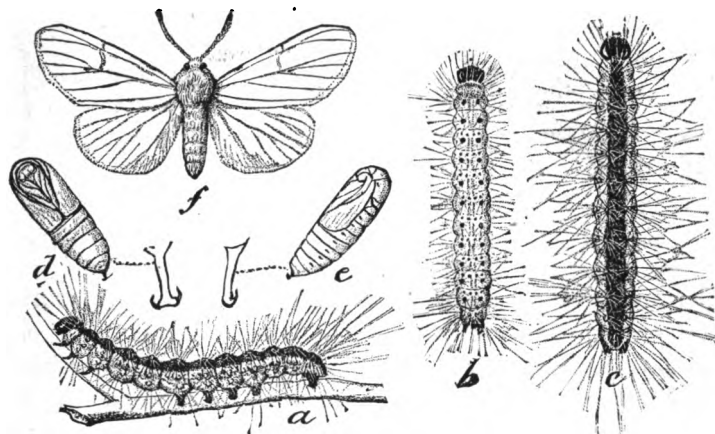


FIG. 27.—The Fall Web-worm (*Hyphantria cunea*): *a*, dark larva from side; *b*, light larva from above; *c*, dark larva from above; *d*, pupa, ventral view; *e*, pupa from side; *f*, adult—all slightly enlarged. [After Riley.]

along the back and one of yellow along each side. They are now covered with moderately long whitish, yellowish or brownish hairs which springs from a series of black and orange-yellow warts. The larva is by no means permanent in its coloration, but varies greatly both in depth of coloring and in the amount of markings upon its body. Two extremes are shown in the illustration at *b* and *c*.

*Moth*.—[Figs. 27, *f*, 29, *c*, and 30, *a*.]—The moth of the Fall Web-worm, like the larva, also varies greatly in its coloration; and, on that account, has been often named. A reference to Fig. 28, *a* to *j*, will show some of the variations under which the insect occurs. The most frequent form here in the West is white, with a faint fulvous tint. The wings are unspotted, the front thighs are tawny yellow and the feet black. Other forms occur in which the wings are spotted. The male moth has its antennæ doubly feathered below, while these mem-

bers in the female have two rows of minute teeth instead. The wing expanse ranges from one and one-eighth to one and three-eighths inches, the male moth being slightly smallest.

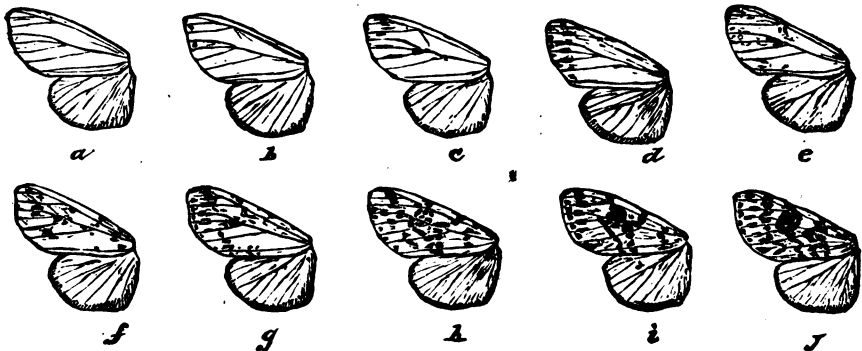


FIG. 28.—Fall Web-worm: a to j, wings showing variations in a series of the moths. [After Riley.]

#### REMEDIES.

In writing of the natural enemies of the Fall Web-worm Professor Riley says: "The caterpillars have comparatively few enemies belonging to the vertebrate animals. This is not owing to any offensive odor or to any other means of defense, but it is entirely due to their hairiness. Chickens, and even the omnivorous ducks, do not eat them; if offered to the former they pick at these morsels, but do not swallow them."

Among the few birds that do feed upon them, the cuckoos are chief, and almost the only ones that habitually destroy any of the hairy caterpillars. Of course these birds are never sufficiently numerous in any locality to keep a pest like this in check; and besides, they are of too retiring a nature to be of much value as insect destroyers in cities and towns. Dr. Riley further states that the Screech owl has been known to feed largely upon the web-worms in the vicinity of Baltimore, Md. The common toads also destroy great numbers of this and other caterpillars when they are creeping about on the ground preparatory to spinning up to change to chrysalids. Toads are great destroyers of insects, good, bad and indifferent, and should be protected from the onslaught of rude boys and kept in gardens and door yards to keep these clear of insects.

A few of our spiders also destroy caterpillars, but these are not of

sufficient importance to count much towards keeping them within bounds. It is among the insects proper that we find the greatest number of enemies to the Web-worm. Among these latter there are those that are predaceous. They capture and eat them bodily or destroy them by sucking away their life-blood until death results. The Armed or Spined Soldier-bug (*Podissus spinosus*), which is shown in Fig. 21, is a great caterpillar destroyer in all of its stages, and should be protected. It also destroys a large variety of other soft-bodied insects.

Of true parasites that attack this insect in one or the other of its stages, Riley mentions six, four of them hymenopterous, and the other a dipterous. The first of these which I will mention is what he calls "THE *TELENOMUS* EGG-PARASITE.—A single egg of *H. cunea* is a very small affair, yet it is large enough to be a world for this little parasite, which undergoes all its transformations within it, and finds there all the food and lodgement required for the short period of its life."\* The female *Telenomus* forces her tiny ovipositor into the egg of the moth and lays one of her own therein. This egg soon hatches inside of the larger one of the moth, and the larva produced soon consumes the contents, becomes full-grown, and transforms to a pupa and later issues as a perfect though very minute insect.

I herewith add the description of this egg parasite.

"*TELENOMUS BIFIDUS* Riley.—Male and female.—Average length, 0.75<sup>mm</sup>; average expanse, 1.75. Color of the body black throughout. Head, three times as broad as long when seen from above; face, especially in the middle, lustrous and without sculpture; vertex polished and without a carina behind lateral ocelli; antennæ black, except bulla, which is honey yellow, eleven-jointed, joints two and three subequal in length. Thorax: Mesonotum very delicately punctulate and furnished with a moderately dense, fine, whitish pile; no parapsidal sutures; legs yellow, except coxæ, femora, and last joints of all tarsi, which are black or blackish; tibial spur of front legs bifid when seen under a high power, and corresponding first tarsal joint furnished with a fine and strong comb of bristles; fore wings with eleven costal bristles and with three cells visible in stigmal club. Abdomen with the second segment striate only at base."

A second egg-parasite of the Web-worm has been bred by the Division of Entomology at Washington, D. C., which belongs to the genus *Trichogramma*, but which was not described. It has similar habits to those of the *Telenomus*, just described. Several of these

\* Riley, in Report of the United States Commissioner of Agriculture, 1886, p. 531.

little egg parasites have been observed by me here in Nebraska at different times working upon the eggs of various moths and other insects. It is needless for me to say that they are among the most useful of our insect friends, since they "nip the evil in the bud."

After the eggs that have escaped from the foregoing parasites have hatched, the larvæ have to run the gauntlet with at least four other parasites. These latter usually attack the half-grown and more mature caterpillars, upon or within the bodies of which they leave their eggs. One of these (*Meteorus hyphantriæ*) is shown in Fig. 31 along with its cocoon. There are at least two broods of this parasite annually. But a single one of these little parasites (*Meteorus*) is reared from a caterpillar, hence each one of them that matures to spin its cocoon means the death of one nearly full-grown caterpillar. It is described as follows in the report already quoted, pp. 532-3:

*METEORUS HYPHANTRIÆ* Riley.—*Female*—Length, 5mm; expanse, 11mm. Comes nearest to *Meteorus communis* Cress, being, however, a larger species. Its cocoons are also larger and of a darker yellow-brown in color. General color, honey-yellow. The irregular reticulation of the metanotum shows less tendency to arrange itself in longitudinal carinæ, particularly into one median and two sublateral. The fine longitudinal impressed aciculations of the first abdominal segment are nearly parallel in *hyphantriæ*, while in *communis* the middle ones converge strongly towards the center behind. The general color is, as in *communis*, yellowish-ferruginous or honey-yellow. In general, *hyphantriæ* has more dark markings than *communis*. The antennæ are dusky at tip; the mandibles are brown at tip; the mesoscutum has two nearly black patches at sides and often a dusky stripe down middle; the metanotum is usually entirely dark, as is also the first joint of the abdomen above; the rest of the abdomen has two larger or smaller dark spots on each side; the sheaths of the ovipositor are dark, especially at base, and the ovipositor itself is honey-yellow; the legs are all honey-yellow except the tips of the hind tibiæ, which are dark.

"*Male*.—Resembles the female, with the usual structural differences. Varies considerably in color, some specimens being almost immaculate, while others are marked like the female. Wing venation in both sexes varies in no way from that of *communis*, and but slightly from that in other species of the genus; in that the second submarginal cell is subquadrate, broadening slightly posteriorly, and in the first transverse cubital nervure being confluent with the recurrent nervure.

Described from eighteen male, nine female specimens, all bred in District of Columbia from cocoons collected near remains of larvæ of *Hyphantria cunea*."

A third but smaller parasite that is equally as abundant and destructive to the caterpillar of the Web-worm as the one just described, is a species described by Riley under the name of *Apanteles hyphantriæ*. He writes, "It appeared somewhat earlier in the season [than did the

*Meteor*], and had killed only half-grown caterpillars. From the numerous old and empty cocoons early in summer, it was plainly seen that a first brood had been quite numerous. \* \* \* \* The white silky cocoon is formed almost under the middle of a half-grown caterpillar, and is fastened securely to the object its host happened to rest upon, and but slightly to the host itself, which is readily carried to the ground by wind and rain, and can therefore only be in position in sheltered places such as cracks and fissures of the bark of trees. But one *Apanteles* is found in a caterpillar, so that each white cocoon indicates, like a tombstone, the death of a victim." This insect is characterized as follows:

"*APANTELES HYPHANTHRIE* Riley.—*Female*.—Length, 3mm. Close to *Apanteles xyli* Say, with which it may be compared. Differs as follows: Mesonotum without the faint median carina or polished posterior margin; scutellum not polished; first abdominal segment about as broad as long, with a quite distinct median carina, the apex of which is polished, and its posterior margin broadly bilobed. In *A. xyli* the first abdominal segment is rather slender, and longer than wide, without distinct carina, and with the apex almost straight. A quite distinct carina on the second segment, wanting in *xyli*. Third abdominal segment coarsely pitted at base, the rest quite distinctly shagreened; in *xyli* the basal punctulation is less pronounced and the rest of the segment smooth. All coxæ black (in *xyli* the apical half of the lower edge of posterior coxæ is reddish); the first joint of metatarsi perceptibly stouter than the other joints (almost like the other joints in *xyli*). Cocoon white and single (in *xyli* the cocoons are enclosed in woolly masses).

"Described from two male specimens."

Still another parasite of this caterpillar is mentioned by Riley in his paper on the Fall Web-worm, which he has determined as *Limneria pallipes* Provanch. This latter insect is much larger than the two species already mentioned; and belongs to the family Ichneumonidæ. Like them, but a single parasite is reared from each caterpillar; and this does not spin a cocoon outside, but remains within the body of its victim until winged. Riley states that it also was very numerous, and did much towards reducing the numbers of caterpillars.

A Tachina or Flesh fly was also bred from the caterpillars of the Web-worm at Washington during the summer of 1886. This latter parasite is also evidently new to science, but was left unnamed for the present until more is known about this particular group of insects.

"Tachina flies are very readily overlooked, because they resemble large house flies both in appearance and flight, and their presence

out of doors is not usually noticed on that account. Yet they play a very important role, living as they do in their larval state entirely in insects. During the caterpillar plague such flies were often seen to dart repeatedly at an intended victim, buzz about it, and quickly

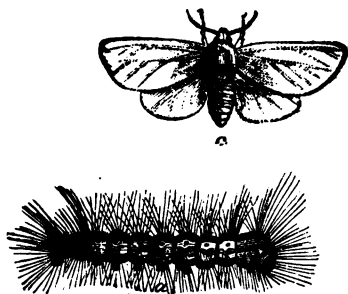


FIG. 29.—Fall Web-worm: a, larva; b, pupa; c, moth. [After Riley.]

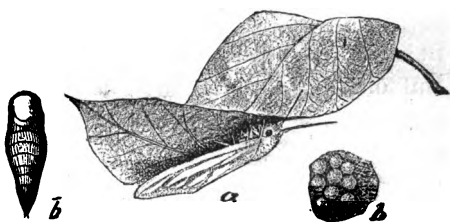


FIG. 30.—Fall Web-worm: a, moth ovipositing on a leaf—natural size; b, a few eggs *in situ*—enlarged. [After Riley.]

disappear. If the caterpillar thus attacked was investigated, from one to four yellowish-white, ovoid, polished, and tough eggs would be found usually fastened upon its neck, or on some spot where they could not readily be removed. These eggs are glued so tightly to the skin of the caterpillar that they cannot easily be removed. Sometimes as many as seven eggs could be counted upon a single caterpillar, showing a faulty instinct of the fly or flies, because the

victim is not large enough to furnish food for so many voracious maggots. If the victim happens to be near a moult, it casts its skin with the eggs, and escapes a slow but sure death. But usually the eggs hatch so soon, that the small maggots have time to enter the body of the caterpillar, where they soon reach their full growth, after which they force their way through the skin and drop to the

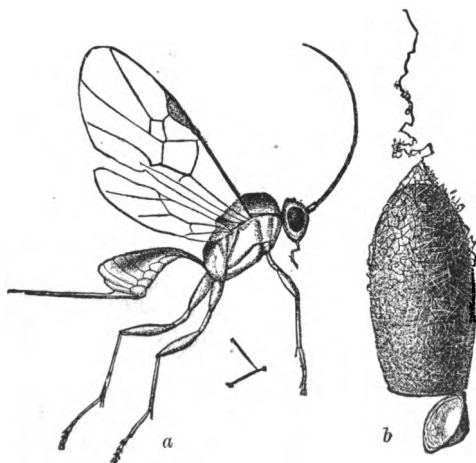


FIG. 31.—The Meteorus Parasite (*Meteorus hyphantrix*): a, adult fly; b, oocoon—enlarged. [After Riley.]

ground, into which they enter, to shrink into a brown, tunlike object (known technically as the coarctate pupa), which contains the true pupa. The caterpillar, tormented by enemies feeding within it, stops feeding and wanders about for a long time until it dies. As a rule, not more than two maggots of this fly mature in their host, and generally but one. The caterpillar attacked by a *Tachina* fly is always either fully grown or nearly so.”\*

When artificial remedies become necessary in order to check or prevent the injuries of the Fall Web-worm, the torch and pruning shears are about the best and most expeditious that can be recommended. Where a torch is used a little caution is necessary in order to avoid, as much as possible, injury to the tree. Of course the arsenical preparations, already referred to on previous pages and in the appendix of this bulletin, will be quite effective when applied in the form of a spray. But the torch is less expensive and fully as rapid, and no risk is run against poisoning either the operator or stock that may be running loose about the place.

### THE WALNUT CATERPILLAR.

(*Datana angusii* G. & R.)

The walnut trees throughout the country are often attacked and stripped of their leaves by a dark-colored, hairy caterpillar that feeds in large colonies. These caterpillars are the larvæ of the moth shown

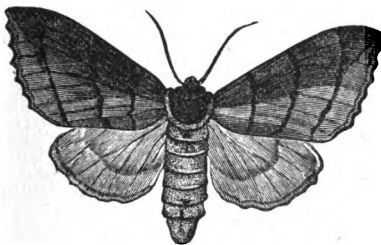


FIG. 32.—Moth of Walnut caterpillar (*Datana angusii*). [After Grote & Robinson.]

at Fig. 32. Here, in Nebraska and in the adjoining states of Kansas, Iowa, and South Dakota, the insect has become so numerous that the growing of isolated walnut trees is more of a task now than formerly. Even on tree-claims, that are not too far removed from the native or natural groves growing along the streams and the planted groves in the older settled portions, it also puts in an appearance before the young trees have reached five or six feet in height. Of course in this case with very injurious results.

\* *Ib.*, p. 535.



The moth that is parent to the Walnut Caterpillar is a dark brown insect belonging to the family Bombycidae among the night-fliers. It is varied in its color by bands of darker and lighter shades, as shown in the accompanying illustration (Fig. 32). Its wing expanse is somewhat variable, ranging in different specimens from an inch and a half to a trifle over two inches, and the male is distinguishable from the female by its slenderer abdomen. It is a rather strong flier when

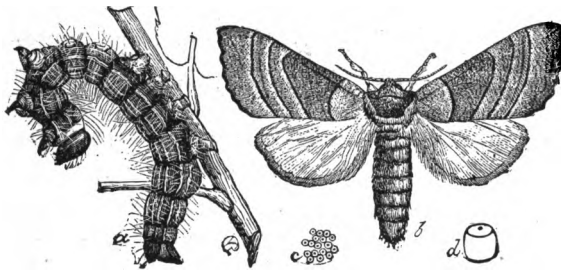


FIG. 33.—The Yellow-necked Apple-tree Caterpillar (*Datana ministra*): a, mature larva at rest; b, moth; c, eggs; d, a single egg greatly enlarged. [After Riley.]

on the wing; but like the moth of the green-striped Maple-worm (*Anisota rubicunda*), is not easily disturbed when attracted to lights. Like several others of the representatives of the family to which

this moth belongs, its larvæ are also quite social in their habits. The eggs from which the young caterpillars hatch are laid in clusters of varying magnitude upon the newer or terminal leaves of the tree intended by the parent moth as food for her offspring. These egg-clusters usually contain from seventy-five to 100 or more eggs, which are of a whitish color. In form they are spherical, and are deposited side by side on the under side of the leaf. Some of them are shown in Fig. 33 at c, which represents a closely allied species, the *Datana ministra* or Apple-tree *Datana*.

When first hatched the young larvæ feed only on the under side of the leaf, that half alone being devoured; but, as they increase in size, they eat the whole leaf except the mid-rib. Dr. Le Baron writes when generalizing upon the habits of the larvæ of the different species of the genus *Datana*: \*

"They do not spin any visible web, but are nevertheless strictly gregarious, feeding in dense clusters and eating clean every leaf as they go. When all the leaves upon one twig or branch are consumed, they hastily migrate to another, sometimes making their appearance upon a remote part of the tree. When not feeding they often rest with

\*Third Annual Report Illinois State Entomologist, p. 187. 1873.

their heads and tails elevated at right angles with the rest of their bodies, and they always suddenly throw themselves into this position when they are disturbed.

"But what is calculated more than anything else to attract attention to these worms, is their remarkable gregarious habit at their moulting periods. They come down upon the side of the trunk, and mass themselves together, very much after the manner of a swarm of bees, sometimes making a quantity as large as could be held in both hands united. They maintain themselves in this position by means of shreds of web extending over and through them. Those which I have particularly noticed remained in this position two days and nights. Before the middle of the third day, those which had first accomplished their moulting began to crawl up the tree, and by the close of the third day nearly all had ascended. During this time they had cast off their out-grown skins, which are left dry and empty, attached to the web. They do not always come down upon the trunk to go through with this operation, but are sometimes seen attached, *en masse*, to the under side of the large horizontal branches." So conspicuous are these cast-off skins as they occur upon the tree trunks or branches, that they not unfrequently produce the belief among non-entomologists that the worms have died or been killed by some disease or parasite. Even in winter many of them are still to be found clinging where their tenants left them; and I have observed remnants of those belonging to broods of two successive summers upon the trunk of the same tree.

After the second or third moult these larvæ or caterpillars become less gregarious than they were when first hatched, and by the time they are full-fed they may be said to be nearly or quite solitary and erratic in their movements. They are then scattered over the greater portion of the tree. When mature the larvæ descend the tree along the trunk to the ground, where they wander off a short distance and enter the earth an inch or two and transform to a reddish-brown or blackish-brown chrysalis. The chrysalids that are formed the last of August live over winter and the following spring just the same as those that become such late in October.

The moths begin issuing here in Nebraska about the last week in June and continue to appear for fully a month longer. They are most numerous about the 15th to 20th of July. The first larvæ are to be seen about the last of July, and others from that time on until frost—

some of the later ones being destroyed before arriving at maturity. Only a single brood of the caterpillars occurs annually. The inequality in the time of the appearance of these different colonies of the caterpillars is due to the variation in development and deposition of eggs by different females that have issued from chrysalids at different times.

As a rule the Walnut Caterpillar shows a preference to trees standing alone or in small clusters, rather than to those growing in dense groves or in the forest. Hence, shade trees on lawns, in parks and along streets and drive-ways, are more frequently attacked by it than are those growing in the former named localities. This seeming preference shown by the insect is probably due to instinct to a certain degree. The parent moth chooses open localities freest from the presence of *Ichneumon* parasites and insectivorous birds for her offspring when seeking a receptacle for her eggs. Then, too, more of the insects mature in open localities and are here to begin with.

In order that the insect may be determined to the entire satisfaction of everyone, I add here the original description of the moth and larva in full:

#### DESCRIPTIVE.

*Moth*.—"Smoky brown. Anterior wings excavate between the nervules along the external margin, blackish brown, with a brighter shade along the costa centrally and above the apical streak. Sparsely and irregularly irrorate with scattered black scales. Five transverse blackish lines run from costa to internal margin. Of these, the first is slightly arcuate. A central discal dot. The second transverse line angulate below costa, running inversely obliquely to internal margin from the disc. This line either intersects or runs inside of the second discal spot, which is formed by an aggregation of darker scales on the discal cross-vein. Third and fourth transverse lines parallel, very slightly arcuate or oblique, faint, especially the fourth, which is quite contiguous to the fifth, and last, transverse line. This latter is very distinct, and slightly irregular and arcuate. There are no paler marginal shades to any of the lines. Apical streak prominent. Fringes dark brown. Posterior wings entire, dark brown, of the same general shade with the anterior wings, gradually shading to paler to the base. A linear median paler central shade, defined inwardly with darker scales. Under surface dark brown. The anterior wings darkest, the coloration becoming more intense towards the internal margin on both pairs. The scales which clothe the head, and those which form the dark thoracic patch, which is characteristic of the genus, are of an intense dark purplish-brown color, narrowly deepening to blackish at the edges. Metathoracic and lateral scales concolorous with anterior wings at base. Abdomen above, pale brownish, with a slight testaceous tinge, deepening in color to anal segments; beneath darker. Antennæ brownish, paler on the inner surface. Legs pale brownish; anterior tarsi and femora clothed with darker scales on their upper surface."

Expanse of wings, male and female, 1.80 to 2.20 inches; length of body, 0.85 inch.

*Mature larva.*—"Head black, shining. Body smooth, purplish-black, clothed with long whitish hair, arranged more densely on the segments laterally, sparse and irregular dorsally. Four pale yellow lines on each side, the lower obsolete centrally above the abdominal legs. The dorsal, swelled portion of the prothoracic ring is black behind, but yellowish immediately adjoining the head. A longitudinal ventral, yellowish line. Beneath, the segments bearing the thoracic legs are purplish-black, concolorous with their upper surface. Abdominal legs flesh-color; thoracic legs blackish." \*

Length about 1.75 to 2 inches.

The larva as described above varies somewhat from the mature caterpillar as most commonly found here in the West. Instead of having the four light-yellow or dirty white lines along the sides as shown at *a* in the figure (Fig. 33), which is that of an allied species, it is almost or wholly black above. There is, however, a single light colored line along the stigmatal region; and sometimes dim traces of other lines show above on the thoracic segments. In their earlier stages the larvæ are furnished with these characteristic pale lines, and the body color is then of a varying purplish-brown color.

#### DISTRIBUTION AND FOOD-PLANTS.

The insect inhabits the greater portion of the Eastern, Middle and Western states, and feeds upon the various species of walnut and hickory. The Black Walnut and Butternut are its preference, and these trees accordingly suffer most from its attacks.

#### REMEDIES.

This caterpillar also has its enemies, both vertebrate and invertebrate, that aid in keeping the insect in check; but it appears that these are not sufficiently active or numerous to do the work necessary to prevent injury to the walnut trees. The moth has, therefore, become a recognized tree defoliator, but little less conspicuous than the several insects treated in the preceding pages of this bulletin.

The larvæ or caterpillars of the Walnut worm are preyed upon by several species of Ichneumon flies; and also by some of the Tachina or flesh flies. Last fall we bred one of these latter, a large, black species, from the pupæ which had transformed in one of our breeding cages. This Tachinid is so large that its pupa almost fills that of the

\* Proceedings Entomological Society of Philadelphia, Vol. VI, pp. 9, 10. 1866.

moth chrysalis, and from which it issues by pushing off a cap or lid at the anterior end.\*

The parent fly deposits several eggs upon the body of the nearly grown caterpillar just back of its head, as shown in the accompanying illustration (Fig. 34) which is that of another species from the one now under consideration. These eggs soon hatch, and the maggots eat their way into the interior of their host, where they grow rapidly. The stronger ones of course overcome the weaker, and thus finally become the sole possessor of the chrysalis shell.



FIG. 34.—Army-worm *Tachina* fly: larva, pupa, imago, and front end of Army-worm showing eggs. [After Riley.]

In a recent article (*Insect Life* for January and February, 1890, pp. 256-7), Mr.

F. M. Webster, of Indiana, refers to the Walnut Caterpillar in the following words:

“The frequency with which the Black Walnut is defoliated by the larvæ of *Datana ministra*† has often been a source of regret to admirers of that beautiful and majestic tree. Every autumn, throughout the Western States, September finds many trees as devoid of foliage as in mid-winter, the fruit hanging to the naked twigs with the very air of disconsolation. Trees in the forest do not appear to suffer, the caterpillars seeming to prefer isolated individuals or small groups, which are usually planted for ornamentation.

“Such a tree stands by the side of the walk midway between my home and the Indiana experiment station, being separated from all others of its kind by nearly a quarter of a mile. During the years 1884 and 1885 this tree was regularly defoliated in August. In 1886, during the usual season, the caterpillars made their appearance and began their work, reaching very near their full growth, when there was a sudden cessation of attack, and the depredators disappeared from the tree with astonishing rapidity, leaving the foliage less than half eaten. This was a change of affairs without precedent.

“An examination of the ground about and beneath the tree at once gave a clue to the mystery, revealing a state of affairs as interesting as unexpected. Everywhere among the short grass and weeds were

\*This fly is undescribed, hence will be called *Tachina datanæ*, for convenience of reference.

†*Datana angustif.*

caterpillars, some of them dead, others dying, while still others were quite active, but all well-nigh covered with eggs of a species of *Tachina* fly. The flies were present in myriads, some of them winging their way about, a few inches above the surface of the ground, and others perched on grass, weeds, etc., all evidently watching for caterpillars, while the latter were as evidently hiding from their persecutors, for no sooner would one of them leave its seclusion than perhaps half a dozen flies would give chase, and begin fastening their eggs to various parts of the body, the victim writhing, twisting, and rolling itself about in the dust, in frantic efforts to escape. Even after gaining a place of security, under some leaf or plant, often some portion of the body would be left exposed, and the already half dead caterpillar would be again driven forth from its hiding, like a gored ox. Four caterpillars, fair samples of the whole lot, were forwarded to the Department at Washington, and to their bodies eggs were attached as follows: No. 1, 213; No. 2, 115; No. 3, 131; No. 4, 228. From five others, collected at the same time, we afterwards reared fifty-three adult flies.

"During the years 1887 and 1888 not a caterpillar was observed on this tree, though others in the neighborhood were infested, but the present year (1889) they returned again in full force."

Among the bird enemies of the Walnut caterpillar, the yellow and black-billed cuckoos are the most important. These birds, as heretofore stated, are, in fact, about the only ones that feed upon the hairy caterpillars.

On account of the social nature of these caterpillars, and their habit of coming down upon the trunk and lower branches to moult, they can very easily be destroyed. They always feed in clusters when young, and can then be taken from the tree and destroyed either by crushing or burning. It is not at all necessary to use poisons for their destruction, since but a few moments are required to rid a tree of one or more clusters of them.

## THE GREEN-STRIPED MAPLE-WORM.

*(Anisota rubicunda Fabr.)*

The insect shown in Fig. 35 is too well known among the inhabitants of portions of Kansas, Missouri and Nebraska to make it necessary for me to inform them of its destructiveness to the soft or silver maple. Especially are the residents of the cities and towns of this region familiar with the work of devastation wrought by the larvæ or caterpillars of this insect now under consideration. Not long since, some space was given to a discussion of this insect's life-history, habits, etc.\* That paper is herewith reproduced in a somewhat altered form, so as to comply with the requirements of this present work.

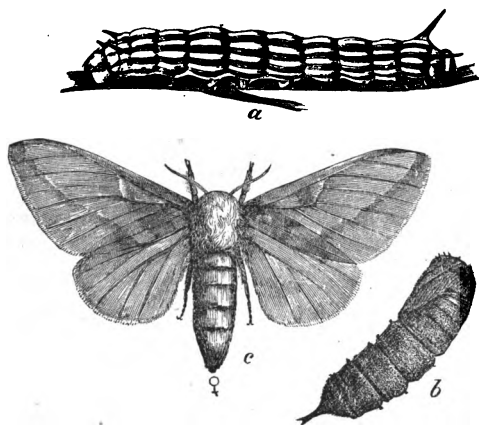


FIG. 35.—The Green striped Maple Worm, or Rosy Forest Caterpillar (*Anisota rubicunda*): a, larva; b, pupa; c, female moth, all natural size. [After Riley].

During the summer just passed, also the previous one, the soft maples along the streets and alleys, as well as those in door yards and on the capitol grounds, in the city of Lincoln, were more or less stripped of their foliage, and rendered unsightly. This was done by the larvæ or caterpillars of several species of moths belonging to the family Bombycidæ, aided by one or more of the Geometrids, or measurers.

Chief among the former was a rather large, smooth worm, longitudinally striped with pale and darker green lines, and readily recognizable from the others with which it was occasionally associated upon the same tree, by two anteriorly projecting black horns or spines emanating from the second segment behind the head.

The following descriptions of egg, larva, pupa, and imago are copied from Professor C. V. Riley's fifth annual report as State Entomologist of Missouri: †

\* Bulletin No. 5, On Certain Injurious Insects of the Year 1888.

† Fifth Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, by Charles V. Riley, pp. 137-141. [1873.]

"The eggs from which the worms hatch are deposited in batches of thirty and upwards, on the under side of a leaf. Each is about 0.05 inch long, sub-oval, slightly flattened, translucent and pale greenish, becoming more yellow, and showing the black head of the inclosed larva just before hatching."

The larva when first hatched is yellowish, cylindrical in form, and has the head large and black. The spines which are present in the full-grown larva are now but little black tubercles. The full grown larva is thus described by the author just quoted:

"Average length, 1.50 inches. General color, pale yellowish-green; longitudinally striped above alternately with eight very light (almost white) yellowish-green lines, and seven of a darker green, inclining to black, the medio-dorsal one usually darkest, and showing palpitations. Characterized by two black, blunt, anteriorly-projecting horns on joint 2; two lateral rows of posteriorly-projecting, more pointed, shorter spines, one (the largest) below and one above the stigmata, and most prominent on joints 10 and 11, which are here somewhat dilated and tinged with rose-red, When examined with a lens the body, both above and below, is found to be thickly studded with transparent granulations, and there are four dorsal polished, subobsolete spines, the anterior on upper edge, and the posterior on lower edge of second dark stripe, and most prominent on joints 11 and 12. Head more or less intense copal-yellow, the ocelli on a black ground; stigmata, in lower dark line, oval, black, with a pale central line; joint 1, with six black elevations on anterior edge; anal shield flattened, greenish, with a black blotch superiorly, and margined with eight black spines, the two terminal stoutest; venter black, with pale mesial line, and a prominent black spine each side, and sometimes others less prominent; legs greenish or yellowish, the thoracic and anal marked with black, the abdominal with rufous claspings."

These larvæ pass through four molts, and attain their growth in about one month. The transformation from the larval to chrysalis stage takes place just below the surface of the ground, or even among overlying vegetable *debris*, as fallen leaves, sticks, etc. This latter is described by the same author in the following language:

"The chrysalis is of a deep brown or black color, very much roughened, and coarsely punctate or pitted like a thimble, with curved horns about the head and thorax, especially at the base of antennæ; a ring of sharp, conical teeth around the anterior edge of the movable joints (stoutest dorsally), one around the middle of the penultimate joint, and several irregular thorns on the apical joint, which terminates in a long projection, bifurcate at tip. The movable sutures have a few coarse punctures on the posterior part, and a very fine longitudinal



striae on the anterior part, which, at the edge, has a ring of small blunt-pointed elevations."

There are two broods of this insect annually, the first brood of the larvæ appearing during the month of June. This first brood, as a rule, is not nearly so numerous as the second, which appears during the months of August and September.

The moth which is parent to these worms is what we call the "Rosy Dryocampa." It is well represented by the accompanying illustration, Fig. 35, c, which represents the female. In color the moth is pale yellow, shaded with pink; but is very variable in this respect, some specimens being nearly or quite yellow, while in others the pink predominates.

The moths of the hibernating chrysalids commence issuing late in May and early June, the time varying slightly according to latitude and the condition of the weather. The sexes then mate, after which the females deposit their eggs in clusters varying in number from forty to seventy-five or more, on the under side of the leaves. These hatch in a week, more or less, when the very young larvæ begin feeding. These at first feed in company, but gradually spread over the adjoining leaves and even to other branches as they increase in size.

Professor F. H. Snow, of the Kansas State University, in speaking of the insect in Kansas, writes as follows:\*

"In nearly all of the towns of eastern Kansas the Silver maple (*Acer dasycarpum*), which grows naturally along the streams, has become the most common shade tree along the streets, by reason of its rapid growth and abundant foliage.

"Ten years ago (1873) it was observed that a few of these trees were being stripped of their leaves by a pale-green caterpillar. The following year the ravages of this enemy were more widely extended, and in 1875 nearly every maple in the city of Lawrence was entirely deprived of its foliage, by the second brood of caterpillars, before the end of August. The writer, however, by waging a war of extermination against the first brood of that year, so reduced the numbers of the second brood that his own shade trees were not noticeably defoliated. The same condition of affairs existed in nearly every town of eastern Kansas. It was hoped that after a year or two this insect, as is the habit of the species in the Eastern States, would disappear from

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\*Quarterly Report of Kansas State Board of Agriculture, December, 1883.

notice. But it has continued its depredations for eleven consecutive seasons [longer now], with varying pertinacity, but in every year to such an extent as to produce complete defoliation of the maples in many localities. Some of our citizens, to avoid the caterpillar nuisance, cut down their maples, thus depriving their premises of all shade until the more slowly growing elm shall furnish a substitute."

The second brood of larvæ mature during the month of September, enter the ground, and live over winter as chrysalids. This brood usually burrows a little deeper than does the first or summer brood, and does not issue as moths until the following May and early June. The spines and horns which decorate the chrysalids are used by them in digging to the surface before disclosing the imago. The species also feeds upon the hard maple, and occasionally upon the oaks.

#### THE INSECT OUTSIDE OF TOWNS AND CITIES.

That this insect is not entirely confined to cities and towns can be attested by those who live on farms in the country. Nor is it confined to regions where forests abound. The moth, although slow and awkward in its movements when at rest, is a good and strong flier, and is capable of making journeys of considerable length when in quest of the proper food-plants upon which to lay its eggs. In this manner, then, the species soon becomes spread over a considerable area surrounding an infested locality; and wherever small maple trees are found the eggs are left, and the insect established. It is by this means that the trees growing on tracks many miles removed from localities known to be infested also soon become likewise infested and injured. These latter trees suffer from its attacks even more severely, if possible, than those in the locality which furnishes the plague, since in these new localities few or none of the enemies, either vertebrate or invertebrate, are present to act as a checking influence.

Besides the maple, this insect also attacks the various species of oaks, which it also frequently defoliates. These are not, however, usually chosen when the maple is at hand. I have also seen the larvæ feeding, to a limited extent, upon the box-elder when they grew by the side of maples that had been defoliated before the caterpillars were fully matured.

## REMEDIES.

Thus far we have seen but two of our birds feeding upon the larvæ of this insect. These were the Robin and Yellow-billed cuckoo. Both of these were quite active in their work during the early part of September, and even as late as the 20th of the month, a flock of more than a dozen robins was seen actively engaged in picking up and swallowing the worms that were creeping along the walks in the vicinity of the capitol. The cuckoos only feed upon those larvæ found on the trees, and being less numerous than the robins, do not destroy nearly so many of them. Professor Snow says,



FIG. 36. — The Gold-baired Tachina fly (*Tachina [Belvosa] bifasciata*). [After Riley.]

that the Blue-bird, the Tufted Titmouse, Red-headed woodpecker, the Red-eyed Vireo and the Crow-blackbird also eat the larvæ. Several others of our birds may also destroy an occasional larva, but not having observed them in the act, or afterwards found the worms in their stomachs, it can but be surmised that such is the case. The imagos also are subject to the attacks of birds. Comparatively few of them are, however, destroyed in this way.

Besides these bird enemies just named, this insect is also subject to the attacks of several Tachina flies and Ichneumon parasites. Of the former, *Tachina anonyma* and *T. bifasciata* are both credited with doing much toward keeping this worm under control. These Tachina flies deposit their eggs upon the body of the caterpillar, so that the maggots as they hatch bore into the body of their host, where they live upon the internal tissues, and thus kill it. Fig. 36, which illustrates the latter of these two species, will give a general idea of the appearance of these flies. An Ichneumon fly (*Limneria fugitiva*) has been known to attack this insect (Riley, 5th Rep., p. 141). A single larva was found by us the past year completely filled with the pupæ of presumably this same parasite.

Here in Lincoln the electric lights have been the means of attracting and destroying large numbers of the moths, while many others were crushed upon the pavements beneath the feet of passers-by. In addition to these modes of destruction, it would be advisable this season to kill as many of the moths as possible as they collect about the lights in the cities. Some of the larvæ, too, are destroyed by being trampled

upon while creeping over the walks preparatory to entering the ground to pupate. A little additional care in gathering these by hand-picking from the smaller trees, and lower branches of the taller ones, would also add greatly towards keeping it within bounds. The eggs, too, the clusters of which can readily be seen, should be destroyed. For the destruction of the worms upon tall trees, as well as for those attacking large groves of the smaller ones growing upon farms, in nurseries or on tree-claims, the use of a spray of London purple or Paris green is recommended. The only practical method for becoming rid of an insect pest is to destroy it. Never try to annihilate it by destroying its food-plant unless by so doing you are *sure* of its destruction. Most of the insects that have so multiplied as to become pests have done so by being capable of adapting their lives to their surroundings by living upon one of *several*, instead of only a single food-plant.

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## THE COTTONWOOD DAGGER MOTH.

(*Acronycta lepusculina* Gn.)

In regions where the cottonwood, willows, and the different kinds of poplars are grown, there is often much damage done to these trees by the larva of the moth illustrated in Fig. 37. This moth is known as the Cottonwood *Acronycta* or Dagger Moth, on account of its preference for that tree as a food-plant. It is especially common here in the West, where the cottonwood and willows are an important factor in the timber supply of the country. The larva or caterpillar is shown at (Fig. 38), where it is pictured curled up—the position usually adopted by it when at rest. It is one of the most abundant species of the genus to which it belongs; and in prairie countries, or rather regions, is counted among our insect pests. As above stated, it attacks the cottonwood and willow, and not unfrequently strips the trees of their foliage. There are two broods of the caterpillars annually, the first appearing in June, and the second in September and October. The second brood passes the winter in the chrysalis stage, transforming early in the following May.

## NATURAL HISTORY.

These insects, this and the two following, belong to that extensive family of night flying moths commonly called Owlet moths, and known to entomologists as Noctuids under the name given above. As a rule, the members of this large family feed by night and rest during daytime. Their larva or caterpillars also remain concealed when the sun shines, only to come forth from their concealment after night-fall to commence their devastations. The



FIG. 37.—The Cottonwood Dagger Moth (*Acronycta lepusculina*). [After Riley.]

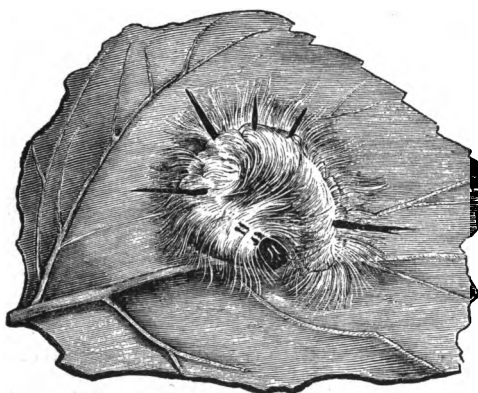


FIG. 38.—Larva of the Cottonwood Dagger Moth. [After Riley.]

cut-worms are representative forms of the group or family. While the larva of a large number of these "owlet" moths are naked, or practically so, others are clothed more or less completely with bristles or hairs. Of the latter, the *Acronyctas* are a good example. The larva of the Cottonwood Dagger, which is so well illustrated in the accompanying figure (Fig. 38), is described as follows by Professor C. V. Riley :\*

"*Larva*—Length 1.50 inch. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, and curl around on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black, with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two less distinct black spots. Thoracic legs black; prolegs black, with brown extremities. Venter greenish-brown. \* \* \* When young of a much lighter color, or almost white, with the black tufts short but more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

"Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a sixth tuft of black hairs on joint 9, and others

\*Second Missouri Report, p. 120.

have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

"*The chrysalis* is dark shining brown, and ends in an obtuse point furnished with several forked bristles.

"*Moth.*—Female, front wings, white, finely powdered with dark atoms, which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with a posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last, and looking like a blurred X, about one-third the length of wing from base, and one subobsolete, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards the base half-way between costa and interior margin, in a transverse line with the large costal spot, which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white, with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed gray above, brown beneath. Head, thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. Male differs from female by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border."

Although the moth of the species now under consideration differs greatly in its size and appearance from the one that immediately follows, the larvæ of the two species bear a very striking resemblance to each other, as can be seen by a comparison of the descriptions.

## REMEDIES.

These caterpillars are attacked and destroyed by several parasites, also by birds. Professor Riley, in speaking of the parasites of this larva, writes:

"This insect would undoubtedly become much more numerous and troublesome, were it not for the fact that it is pursued by three distinct parasites. Many of the worms when full grown will fasten themselves firmly to a leaf in the curled position, and from the body will issue from thirty to forty little maggots. These maggots are each of them 0.17 inch long, of a dull green color, tapering each way, with a dark dorsal mark, a lateral elevated ridge, and a row of shining elevated spots of the same color as the body between this ridge and the back. Each one spins a mass of white silk around its body, and creeps out of it and commences spinning afresh, until at last a large aggregate amount of flossy silk is spun, into which the maggots work back to transform, though some transform while lying on the surface. These maggots eventually produce a little black Ichneumon fly belonging to the genus *Microgaster*. Another and larger undetermined Ichneumon fly, belonging to the genus *Ophion*, also attacks this Cottonwood worm, and it is also occasionally infested with a *Tachina* fly larva." The past summer it appears that this last named parasite, or an ally, was even more effective in killing off the caterpillars of *A. lepusculina* than were the Ichneumonids spoken of by Riley. Professor Otto Lugger, in Bulletin No. 9 of the Minnesota Agricultural Experiment Station, writes (p. 61): "Although very numerous and destructive early in the season, the second brood was almost destroyed by a number of parasites, but chiefly by a *Tachina* fly.

The worms can be destroyed by spraying the trees with either London purple or Paris green. On small trees, however, hand picking can be resorted to. In fact this latter method of destroying the worms is quite feasible on account of their partially gregarious nature and conspicuousness.

## THE MAPLE-TREE DAGGER MOTH.

*(Acronycta americana Harr.)*

This, the largest of our Nebraska representatives of the genus *Acronycta*, is a very common, and, at the same time, injurious insect in many portions of the region where tree claims are cultivated. "Its body and fore wings are light-gray; on the latter there is a wavy, scalloped white line edged externally with black near the outer hind margin, and the usual round and kidney-shaped spots are also edged with black; the hind wings are blackish in the female, with a faintly marked black curved band and central semicircular spot on each; the fringes are white, scalloped, and spotted with black. Its wing expanse is from two and one-quarter to two and one-half inches, or even more in some specimens." Like the preceding species, this moth is a night-flier, and can be readily attracted to lights and destroyed.

The larva or caterpillar is very similar to that of the Cottonwood Dagger, but can be distinguished from it "by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joint 11, one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus."\*

When ready to transform, it crawls to some sheltered spot, as a fence, in crevices of the bark of trees or under sticks and other *debris* lying upon the ground, where it spins a loose web of silk intermingled with its body hairs: inside of this it then forms a second and tougher cocoon of silk, fragments of bark, wood or whatsoever else it may have at hand. Within this cocoon it transforms to the chrysalis and remains over winter. Two broods occur annually here in Nebraska; the moths for the first, appearing during the months of May and early June, and for the second, during August and September.

## FOOD-PLANTS.

The *Acronycta americana* feeds upon a large number of trees and shrubs. Of these the following is a partial list: basswood, mock

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\*Riley, Second Missouri Report, p. 121; Index to Missouri Reports, p. 74.



plane tree, silver maple, horse chestnut, black-cherry, service-berry, choke-cherry, common and dwarf blueberry, elm, hickory, oak, beech, chestnut, coffee-bean, birch, locust, walnut, blackberry etc.,—a very formidable list indeed, when we take into consideration the food-habits of the majority of our other species of the genus *Acronycta*.

#### REMEDIES.

Among the parasites of this and the Cottonwood *Acronycta* here in the West is a small reddish-brown Ichneumon fly with clear wings. This parasite attacks the larvæ in a similar manner with the *Microgaster* mentioned in connection with the Cottonwood moth. It lays its eggs in the body of its victim. These eggs hatch into small footless grubs that live upon the fat and other tissues of the host's body until the latter is about full-grown, when they attack the vitals. Just before dying the caterpillar attaches itself quite firmly to the under-side of a leaf, or upon a twig, with a little silk. In this position it clings through winter if upon a twig, or falls to the ground if fastened to a leaf. The parasitic grubs now spin cocoons for themselves within the body of the dead caterpillar skin and transform to pupæ with the head end directed dorsally, soon to issue as full-grown flies. In issuing, each of these parasites cuts a circular hole through the

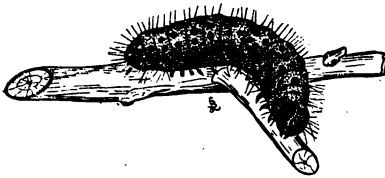


FIG. 39.—*Acronycta* larva killed by *Rhogas intermedius*. [Original.]

skin of the host, leaving it appearing like the lid of a pepper-box. During the past summer this parasite (*Rhogas intermedius*)\* was exceedingly common here in the city of Lincoln. Figure 39 shows the appearance of one of these caterpillars after the Ichneumon parasites have escaped.

Although quite common at times, these *Acronyctas* but seldom become so numerous upon small trees on new land away from the immediate vicinity of old groves, as to prove destructive. Even if

\* Transactions American Entomological Society, Vol. II, p. 380. (1869.)

"*Aleiodes intermedius*.—Male and Female.—Small, slender, luteus or dull honey-yellow; spot on vertex about ocelli, metathorax, patch beneath wings, and most of first abdominal segment, black or fuscous; metathorax finely sculptured, with sharply defined central carina; wings hyaline, iridescent; nervures fuscous; stigma whitish, varied with fuscous; first, second, and third (except tip) abdominal segments finely longitudinally aciculate. Length, 2-2½ lines.

"Sometimes the blackish markings of thorax and abdomen are entirely wanting."

"Habitat.—Eastern, Middle, Southern, and Western States."

they did they could be quite easily controlled by the use of Paris green or London purple, or even by hand picking.

## THE SMEARED ACRONYCTA.

(*Acronycta obliterata* Sm. & Abb.)

A third species of *Acronycta* is shown herewith in Fig 40. It is the one known as the Smeared Dagger-moth, on account of the partial obliteration of the dagger-like markings at the base of the anterior wings—these being “smeared” over as it were with other colors. The illustration shows the insect in its various stages of larva, *a*, the cocoon or chrysalis case, *b*, and the moth, *c*.

The larva or “worm” of this *Acronycta* is quite different in appearance from those of the two species preceding. It is a hairy caterpillar also, but has these hairs or bristles arranged in clusters emanating from a series of tubercles or wart-like elevations. In length this caterpillar measures about an inch and one-quarter to an inch and one-half; in color it is deep velvety black, brightly ornamented with red and yellow. Upon each segment there is a transverse row of tubercles.

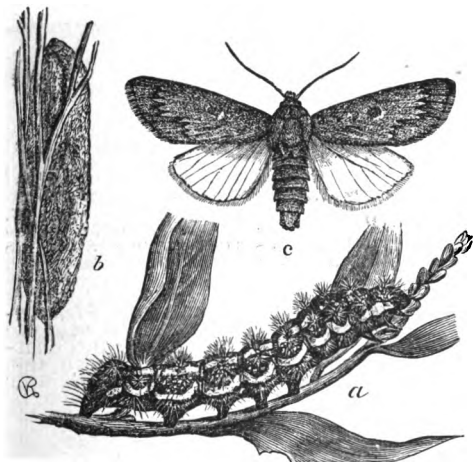


FIG. 40.—The Smeared Dagger Moth (*Acronycta obliterata*):  
a, mature larva; b, cocoon; c, moth—natural size.  
[After Riley.]

From each of these tubercles there arises a tuft of short, stiff hairs, those on the upper part of the body being red, while below they are yellowish. The light markings in the illustration are bright yellow in the living insect, while the spiracles, or breathing pores, are white. There are also a few whitish dots scattered over the body. When full-grown the larva draws together a few leaves or other loose material in which it constructs for itself

a rough cocoon. In this cocoon it transforms to a dark brown chrysalis. There are two broods annually. One of them appears in June

and July, and the second during September and October. This last brood of larvæ is usually the one that does the damage, but not always. During the past summer it was observed in numbers sufficiently great to completely defoliate a small clump of willows growing along a stream near Broken Bow, Custer county, this state.

The moth that is parent to these larvæ is a very plain looking insect, of the same size and general appearance as the accompanying figure. Its front wings are gray, with a row of small black dots along the hind border. There is also a broken zigzag line of the same color across the wing beyond the middle, which, in some specimens, is quite dim. In addition to these markings, the middle area of the wing is provided with dark gray spots. The hind wings are white.

#### FOOD-PLANTS.

The larva of this insect is one of our commonest caterpillars, and is a very general feeder. Among these food-plants the following list will give some idea of its natural adaptability to circumstances: It is a common enemy to the strawberry, grape, bean, smart-weed, a number of grasses, peach, apple, willow, poplar, and a large assortment of herbaceous plants. Here in Nebraska and South Dakota it is a very, common, and quite frequently injurious insect upon the tree-claims where it attacks willows and cottonwoods.

#### REMEDIES.

This caterpillar has its natural enemies, like all of its allies, that usually keep it within reasonable bounds, especially in the older settled districts, where these parasites and predaceous insects find shelter. Professor C. V. Riley mentions three parasites that work upon this insect,\* of which he says:

"The largest of these is the Uni-banded Ichneumon fly (*Ichneumon unifasciatus* Say), a large black fly, 0.60 inch long, and characterized by a white annulus about the middle of the antennæ, a large white spot about the middle of the thorax, and a white band on the first joint of the abdomen.

"This fly oviposits in the larva of the Smeared Dagger, but the latter never succumbs till after it has spun up and become a chrysalis, for I have always obtained the Ichneumon from the chrysalis. The other

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\*Third Missouri Report, p. 71. 1871.

parasites are smaller and work differently. They each cause the larvæ of the Smeared Dagger to die when about full grown, and its contracted and hardened skin; which may often be seen during the winter, with the head attached (Fig. 41, a), fastened to the twigs of apple and willow trees, forms a snug little house where the parasite undergoes its transformations and through which it gnaws a round hole (Fig. 41, b), to escape the latter part of April. One of these flies (*Aleiodes rileyi*, Cress.) \* \* \* is of a uniform reddish-yellow color.

The other is a black fly of about the same size, but belonging to an entirely different genus, *Polysphincta*. It has two prominent carinæ on the dorsum of the basal joint of the abdomen, and the legs, except the hind tarsi and last half of hind tibiæ, are rufous."



FIG. 41.—*Acronycta* larva killed by parasite. [After Riley.]

When the larvæ of this moth become so numerous that they cannot be destroyed by hand picking, the London purple or Paris green remedies so frequently referred to before will serve the purpose.

For those who may want to examine the insects herein described more carefully, descriptions of the various stages of the Smeared Dagger are appended. These descriptions are copied from the report just quoted above:

"*ACRONYCTA OBLINITA* Sm. & Abb. — *Imago* — Front wings oblong, apex more or less prolonged; posterior margin sometimes rounded, sometimes straight; color ash-gray, caused by numerous dark brown atoms more or less suffused on a white ground, from which the ordinary lines are barely discernible in the better marked individuals; a row of distinct black dots along posterior border; the ordinary spots represented by blurred marks or entirely obsolete; the undulate line across the posterior fourth of wing distinct, and relieved inside by a pale coincident shade, with the teeth quite aciculate and with the *psi*-spot so characteristic of the genus, but rarely traceable; fringe narrow and generally entire. Hind wings pure white, with a faint row of dark spots around posterior border. Under side of both wings white with faint fulvous tint and faint irrorations; each wing showing the brown discal spot, and the row of points at posterior border. Head and thorax speckled gray; abdomen whitish-gray; antennæ short, simple in both sexes, gray above and brown below; palpi small. Two specimens with the front wings very dark, showing the ordinary lines and spots conspicuously, and with the brown above as well as below. Average length, 0.75; expanse, 1.75 inches.

"Described from numerous bred specimens.

"*Larva*. — Prevailing color black. Each joint with a transverse dorsal crimson-red band across the middle from stigmata to stigmata, and containing six warts, each furnishing ten or twelve, or more, stiff yellow or fulvous bristles, and the two dorsal ones being farthest apart. A sub-dorsal longitudinal yellow line inter-

rupted by this transverse band and at incisures, in such a manner that the black dorsum appears somewhat diamond-shaped on each joint. A broad, wavy, bright-yellow stigmatal line, containing a yellow bristle-bearing wart in middle of each joint. Lateral space occupied with different sized pale yellow spots, largest towards dorsum. Head chestnut-brown. Venter crimson-black, with bristle-bearing warts of same color. Stigmata oblong-oval and pale. Thoracic legs black; prolegs with black extremities. Such is the normal appearance of this larva, but it is very variable. In some the yellow seems to predominate over the black, and there is a more or less distinct dorsal line. In some this dorsal line forms a mere speck at the incisures of the middle joints. The transverse crimson band is often entirely obsolete, and the warts distinctly separated, while in others where this band is distinct, the warts coalesce.

"*Pupa*.—Almost black, and shagreened with the exception of a smooth and polished rim, at posterior border of joints, which becomes reddish, especially ventrally, on the three joints immediately below wing-sheathes. Terminal joint horizontally compressed, squarely cut off, and furnished with a little brush of short evenly-shorn, stiff rufous bristles."

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## THE ASH SAW-FLY.

(*Monophadnus bardus* Say.)

The foliage of the ash trees in the West, especially in the states of Nebraska, South Dakota, Iowa and Kansas, is attacked by several species of insects, either of which frequently become sufficiently numerous to completely defoliate small trees, and sometimes even groves of this tree are thus defoliated several years in succession. One of these ash tree insects is a species of saw-fly, and has been recently described as follows by Professor E. A. Popencæ, of the Kansas Agricultural College and Experiment Station:

"Feeding very abundantly, in May, upon the leaves of the ash tree, a yellowish green twenty-two-footed slug about one inch in length, with a darker translucent line along the back and along each side; transforming in the following spring into a four-winged fly about one-third inch in length, in color black, with the thorax above and in front dull orange or honey red.

"During several seasons the ash plantations upon the college grounds, especially the white ash grove upon the upper farm, have suffered more or less injury through the attacks of the larvæ of saw-flies of several species, the *Monophadnus bardus* (Say) being much the most numerous represented. In 1886 and 1887 the abundance of the larvæ was such that the leaves were in many cases entirely

stripped from the trees, numbers of the larvæ dying from starvation. In 1888, though the parent flies appeared in great abundance, the larvæ were less than usually numerous, owing doubtless to the prevalence of cold, rainy weather, which prevented the activity of the flies in the season of egg laying.

"The adult insect appears from the last of April to the middle of May, the male preceding the female two or three days. The insect is

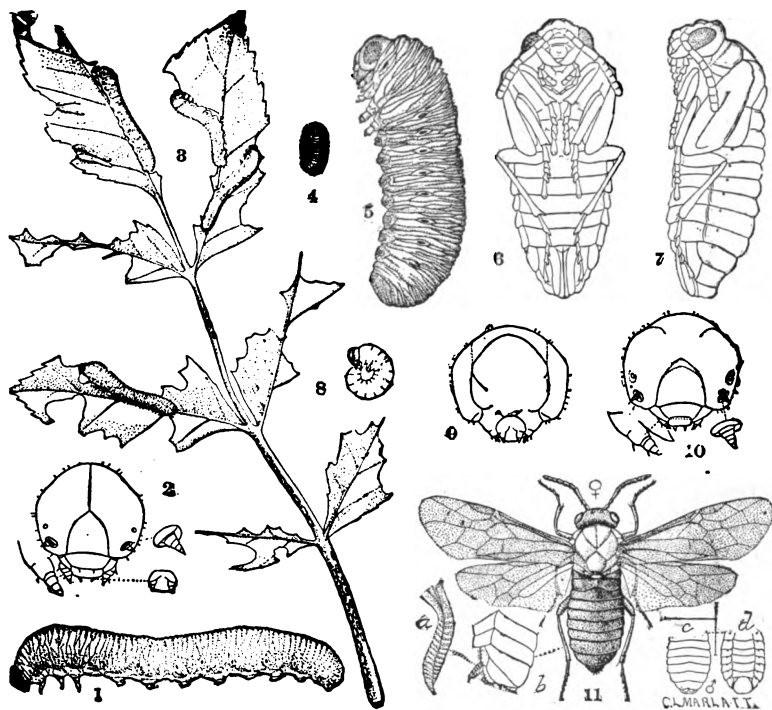


FIG. 42.—The Ash Saw-fly (*Monophadnus bardus*): 1, larva; 2, head of the same more highly magnified; 3, leaf showing larva and work, natural size; 4, cocoon; 5, larva, shrunk, just before transforming to pupa; 6, 7, pupa; 8, larva curled up; 9, 10, head of another species of *Monophadnus*; 11, female fly, *a*, its saw; *b*, portion of abdomen; *c* and *d*, male abdomen. All enlarged but Nos. 3, 4, and 8. [After Marlatt.]

very short lived, the adult period not exceeding ten or fifteen days. The date of the appearance of the adult is somewhat irregular; single individuals were noted as early as April 1, and others after the middle of May, the period of greatest abundance being about May 1, at which time a sweep of a collecting net secures them by the hundred.

"Ordinarily the flies do not leave the locality where they were bred, and after their season may be found dead, thickly scattered on the

ground about the infested trees. Hence their migration to neighboring ash groves has been slow, and they have not been noted in such great profusion in newly planted groves away from those first mentioned.

"Aside from the injury of oviposition, the flies themselves are incapable of injuring the trees. They apparently feed, to some extent, upon the grains of a whitish, waxy substance that occurs upon the surface of the freshly expanded leaves, as individuals of both sexes have been seen clearing the leaf surface of this substance.

"In the act of oviposition, the female thrusts her sawtoothed ovipositor (Fig. 42, 11 *a*) under the epidermis at the edge of the upper face of the petiole or mid rib of the leaf. Then, by a forward and outward thrust, a cavity is formed in which the egg is at once laid. The ovipositor being withdrawn, a step forward is taken, and the operation is repeated, until from three to a dozen eggs are laid, when a change of position may be made. When the space is not filled, the eggs are commonly laid under the epidermis of the petiole at the edge of the upper or concave side only, but when this part is occupied, other parts are brought into requisition, so that not unfrequently eggs will be found in double or quadruple rows over every available section of the petiole and midrib, or even on the bud scales. In two instances, indeed, the flies were seen placing eggs in the edge of a leaflet. While employed in egg laying, the insect is not easily disturbed, so that the observer may use a hand glass and watch the operation at his convenience.

"The egg is oblong-oval, colorless, and about one millimeter in length; and toward the time of hatching the outline of the larva, and more distinctly the dark colored head, becomes visible through the shell. It is interesting to note that these unhatched larvæ are arranged with great regularity, backs outward, and heads turned toward the leaf tip.

"The period of oviposition extends through about twenty days; beginning in 1888 upon April 25, it continued until May 15. In a few instances, freshly placed eggs were observed as late as June 5th. In nine or ten days after the egg laying season has begun the first larvæ are seen, the greatest number appearing from the 10th to 20th of May. They at once begin to feed, and as they group themselves, often as many as fifty or more together, upon a single leaf, their work

soon becomes noticeable. Scattering colonies of these gregarious young have been observed as late as June 15th. In their usual abundance, the sound made by the myriad jaws cutting into the leaf tissues is distinctly audible in the midst of the grove, and may be compared to the sound of fine rain drops upon the foliage. Excepting a few of the coarser veins, the leaf is eaten entire, and soon the larvæ must travel in search of food. They are then often so numerous as fairly to whiten the trunk and branches over which they must crawl."

The larval development of this insect may be briefly described by the following notes upon the brood of 1888, as recorded in the note book of Professor Popenoe:

"MAY 4.—The *first larvæ* observed. Newly hatched, they may be described as follows: Length, 2.75 millimeters; head, .45 millimeter in diameter, shining black; body yellowish white, smooth, with transverse wrinkles; thoracic segments of somewhat greater diameter than those of the remainder of the body; thoracic feet marked with dark; abdominal feet whitish.

"MAY 6.—*First moult*: Length of larva, 4<sup>mm</sup>; head, .65<sup>mm</sup> in diameter.

"MAY 8.—*Second moult*: Length of larva, 7<sup>mm</sup>; head, .91<sup>mm</sup> in diameter.

"MAY 10.—*Third moult*: Length of larva, 11<sup>mm</sup>; head, 1.35<sup>mm</sup> in diameter.

"MAY 11.—*Fourth moult*: Length of larva, 15<sup>mm</sup>; head, 1.75<sup>mm</sup> in diameter.

"MAY 17.—*Larvæ full fed*: Length, 20–25<sup>mm</sup>; head, 1.75<sup>mm</sup> in diameter. The larva at this age has the head shining dark brown; mouth parts lighter; thoracic feet dark spotted; abdominal feet light; skin in numerous transverse folds and wrinkles; color yellowish-green, with a dorsal and lateral line darker, translucent.

"After reaching full size, the larva passes its *fifth moult*, but with little change in size. The colors are somewhat altered, the head becoming gray brown above, and of a light flesh color in front and below the small black eye spots. The body is of a smoky color, darkest on the back, yellowish on the sides and beneath, somewhat shining; thoracic feet light.

"After the fifth moult the larva does not feed, but, rapidly contracting to one-third or one-half its former length, enters the soil to a



depth of from one-half inch to three inches, commonly about one inch, constructs an oval earthen cocoon about one-half inch long, lined interiorly with a brownish silk. In this cocoon the larva remains unchanged until March or April of the following year. In the breeding cage, where a series had been reared, all had pupated by April 16, and flies were already appearing; but in the ash grove few pupæ were found at that date, the unchanged larvæ being in great preponderance. On April 19th, its first flies were noted in the grove; on the 21st they were common, and on the 25th in greatest abundance,—many in coitu and others depositing eggs. The observations of three successive seasons indicate that the saw-fly is single brooded."

These notes given above refer to the insect as it occurs in the vicinity of Manhattan, Kansas, where it is evidently much more plentiful than as far northward as Holt county, Nebraska, where I have had my greatest experience with it. At this latter locality it is fully two weeks later in making its appearance in spring, and consequently continues that much longer into June. It is also a very common insect pest at West Point, in this state, as well as here in Lincoln. In both of these localities it frequently does much injury to ash trees, by completely stripping them of their early foliage. In Iowa and South Dakota the species also occurs; but, so far as I am at present aware, it never becomes so excessively numerous in these last named states so as to be dreaded. Mr. Say's type was taken in the state of Indiana.

While this and other species of saw-flies do not show as great a tendency to migrate as do many other insects treated in the present bulletin, they are sufficiently migratory in habit to make their appearance very soon after a claim has been planted to ash trees. This is true where the nearest infected region is several miles away.

#### REMEDIES AND ENEMIES.

Like all other insects with which we are acquainted and have to deal, the Ash Saw-fly has its natural enemies. These are both parasites and predaceous insects, reptiles and birds. Professor Popenoe in speaking of these writes as follows:

"Larvæ were frequently noticed with the eggs of a dipterous parasite attached to the skin of its back, and from some of these were bred

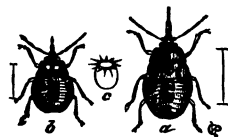


FIG. 43.—Armed Soldier Bug: a, pupa; b, mature larva; c, egg. [After Riley.]

a number of specimens of a small *Tachina* fly, appearing in April and May. *Metapodius femoratus* (Fig. 44, b) and a common species of *Podisus* (Fig 43), both large bugs allied to the Squash bug, and commonly supposed to be exclusively plant feeders, were observed preying upon the larvæ of the saw-fly. A species of paper wasp (*Polistes*, undetermined) was repeatedly seen stinging and carrying off nearly

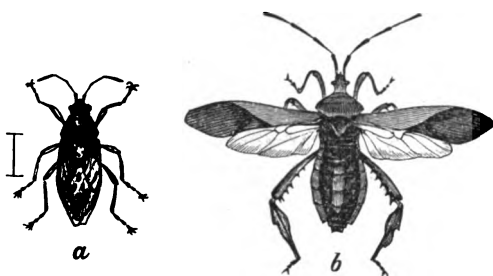


FIG. 44.—b, *Metapodius femoratus*.

full-grown individuals, and *Ichneumon* flies were so numerous in the grove as to intimate the saw-fly larvæ to be the object of their attention, though no ichneumonized specimens were secured. In addition to insect enemies, birds were observed to destroy the

larvæ and at all hours of the day. As showing one natural check upon the increase of this insect, it should be stated that upon May 27, 1888, while the larvæ were abundant, there occurred a heavy hail storm, and a visit to the grove the day following showed the larvæ lying dead upon the ground in great numbers."

Being a leaf-eater this insect can very readily be destroyed by the use of any of the arsenical poisons. These can be mixed with water and sprayed upon the foliage with a force pump. Either the London purple or Paris green can be used for this purpose, in neither case using more than four ounces to the barrel (45 gals.) of water. The poison should be kept agitated by stirring the water from time to time while spraying.

Where only a few trees are to be kept free from this saw-fly, as, for example, in lawns or along walks, hand picking will be effectual, since the season for egg-laying and larval life is limited to but about 30 days during May and early June. In this instance a single gathering, or, at most, two such overhauls, will secure the destruction of the insects sought. Usually a heavy jarring will dislodge the worms, and they can then be killed upon the ground. The simple jarring of the larvæ to the ground will not suffice, since they will all or nearly all return to the tree if not killed.

## THE LARGE WILLOW SAW-FLY.

(Cimbex americana Leach.)

The insect which is shown in Fig. 45 frequently becomes sufficiently numerous to completely defoliate the white willows growing as hedges in portions of Nebraska and adjoining states. It also infests the different native willows growing along the smaller streams back from the

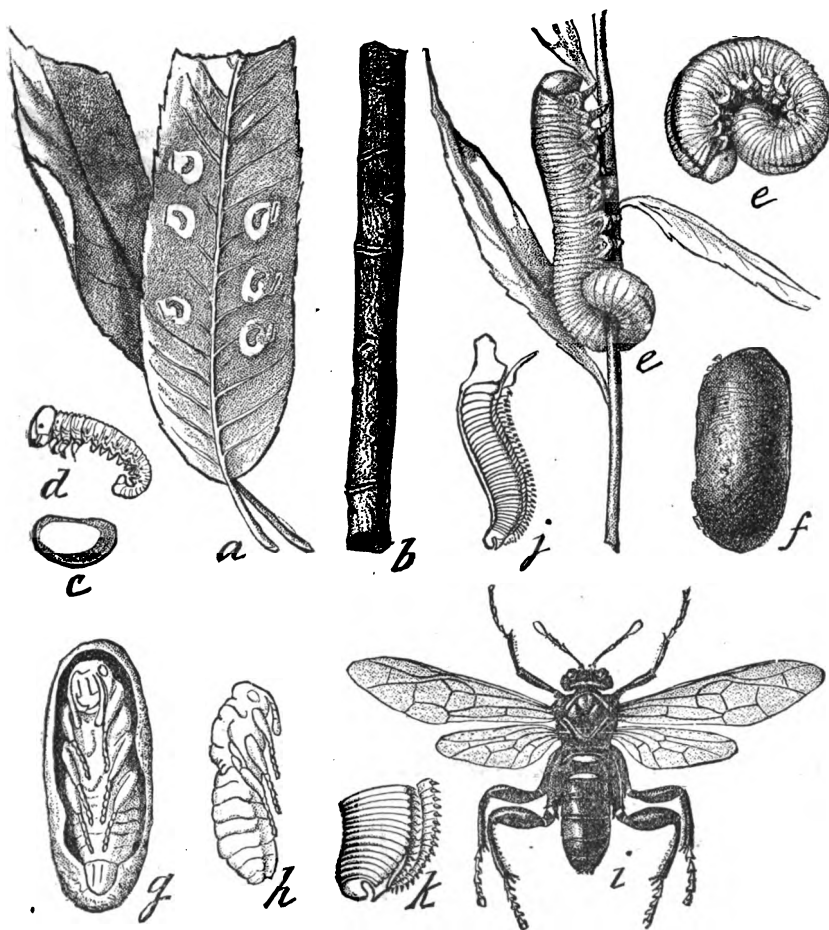


FIG. 45.—The Large Willow Saw-fly (*Cimbex americana*): a, willow leaves showing egg-blisters from above and below; b, twig showing girdlings; c, egg; d, newly hatched larva; e, e, full-grown larva; f, cocoon; g, cocoon cut open, with pupa; h, pupa, side view; i, male fly; j, saw of female detached, side view; k, tip of do.—c, d, j, k, enlarged, the rest natural size. [After Riley.]

timbered belts bordering the larger water courses. The insect is injurious both in the mature and larval stages; the latter to the leaves, and the former to the twigs.

The larvæ are large cylindrical, glaucous, yellowish-white worms, as large or larger, when full grown, than those in the illustration at *ee*. These larvæ have a rather broad dark line running along the middle of the dorsum or back; and they are very much wrinkled or ridged transversely, like the shells of some snails. When disturbed they curl up and eject a watery fluid from certain pores in the skin. These pores are situated along the sides just above the spiracles or breathing pores. They also habitually keep their bodies partially coiled when at rest or even during feeding, as do the majority of the larvæ of this group of insects.

The above is an abridged description of the larva of our largest saw-fly, the parents or perfect insects of which remind one very forcibly of a bumble bee when flying, and of a large hornet when sitting. This resemblance to those insects is not entirely chance, for like them the saw-flies, of which there are many species in this country, belong to the same order or great division of insects, *i. e.*, the Hymenoptera—a very variable group indeed as to feeding habits. These saw-flies approach the Lepidoptera (butterflies and moths) in the feeding habits of their larvæ; and hence all of them belong to what we term “injurious insects.”

The parent flies of this particular species are as large as the accompanying illustration, Fig. 45, *i*. The female has the head and thorax shining black. Her body is oval, and of a steel-blue or deep violet color, with three or four elongate oval yellowish-white spots on each side, which in some specimens are much larger than in others, and uniting above form continuous bands across the upper side of the body. Her antennæ (feelers or “horns”) are buff colored, except at the base, where they are dusky; they are rather short, and end with an egg-shaped knob. Her wings are fuliginous or smoky-brown, and semi-transparent. The legs are blue-black, with yellowish feet. The male differs from the female in its slenderer and longer body, in the absence of, or in having the spots of the side nearly obsolete; and there is a transverse, oval hole, filled with a whitish film or membrane, just behind the thorax, which is hardly perceptible in the female.

During the past five or six years the larvæ of this large saw-fly

have been numerous, and consequently destructive to the willow hedges planted over the prairies of the state. It has been especially numerous in Dodge and Cuming counties, Nebraska, where most of the hedges upon the more elevated ground have been repeatedly defoliated for several years in succession. While it appears to be generally dispersed throughout the region, its injuries appear to be confined chiefly to trees growing upon the more elevated grounds lying back from the main water courses. Of course there must be a reason for this particular phase of the distribution in injurious numbers of it; but just what this cause is to be attributed to we are not quite prepared to state at present. Perhaps the work of shrews, mice, and other small mammalia has much to do with keeping down their numbers on low grounds, by devouring the pupa during their hibernating period.

The eggs of this insect are laid during the early part of June, and the larvæ become full grown by the 20th to the last of July. When mature these enter the ground, seldom more than barely covering themselves, where they spin for themselves coarse, tough, silken cocoons in which they undergo their transformations. They remain in this situation until the following May before issuing as imagos.

#### REMEDIES AND ENEMIES.

Thus far I have been unable to ascertain whether or not these particular saw-flies have parasites attacking them in any of their stages of growth; but it is to be presumed that they have, for other saw-flies are known to suffer from the attacks of predaceous insect enemies and parasites. Out of upward of 400 pupæ collected and put aside for the purpose of rearing any possible parasites, not one was obtained. Neither have I observed fowls destroying them. Yet it would be hasty for me to assert that they would not do so if given a chance.\* As before hinted it is to be presumed that mice, moles, and shrews, as well as other vertebrates, destroy the pupæ of this and various other insects, knowing as we do the miscellaneous nature of their food. Mice, shrews, chipmunks, and moles are known to destroy many insects during the fall, winter and spring when other food is scarce. Even the troublesome ground squirrels have recently been ascertained to live

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\* Professor Otto Lugger, in speaking of this insect's enemies in a recent bulletin of the Minnesota Experiment Station, says: "This giant among our saw-flies seems to have few enemies. Yet it is not without them, and I have at this time a number of pupæ of a *Tachina* fly in the breeding cages. As many as six eggs of this useful insect were found upon one larva."

preferably upon such insects as grasshoppers and cut worms. In the woods and along the streams we are aware that many of these smaller mammals habitually congregate; hence the scarcity of many injurious insects that would otherwise be supposed to be present here in force. Predaceous insects, too, are always present here in force, while parasitic forms find shelter there. Insectivorous birds are there too, so as to keep these insects in check year in and year out. Upon the uplands and on the prairies these checks to insect increase are not present; therefore, the multiplication and consequent injuries.

So numerous has this insect been on several occasions that they completely stripped the trees before the larvæ were matured, and the consequence was that they starved to death.

As a direct artificial remedy against the depredations of the willow saw-flies (*Cimbex americana*) I would suggest hand picking. On account of their gregarious nature, large size, and habit of dropping to the ground at the least disturbance, this means of gathering them is quite practical. Their single annual brood, too, favors this remedy. After the last worms have disappeared from the trees, clearing away the rubbish from beneath the trees with a common garden rake, and afterward burning it, will destroy many of the pupæ. The keeping of "clean" hedge rows and supplying of an artificial retreat for the larvæ, might save time and do much toward keeping in check this and other injurious insects. A mulching of finely cut straw would answer admirably for this purpose. In extreme cases, where the proper mechanical appliances were at hand, a thorough spraying with arsenical poisons such as London purple, Paris green, or even with white arsenic itself, might be profitably employed. These should be used with great caution, and in solutions sufficiently weak not to blister the foliage, and, at the same time, strong enough to kill all the worms. For arsenic the preparation should not be greater than three or four ounces to fifty gallons of water, probably less; and for Paris green and London purple mixtures, double the weight is required.

Besides willows, this saw-fly is known also to feed upon the elm, birch, and linden or bass wood.

## THE YELLOW-SPOTTED WILLOW-SLUG.

*(Nematus ventralis Say.)*

There is a second and smaller species of saw-fly that attacks different willows throughout the Mississippi basin and elsewhere in North America. This latter insect is much smaller than the *Cimbex* just described, but is equally as injurious as the large one. In some seasons it may prove even more destructive than that species; because, instead of being single brood, it is many brooded. Here in Nebraska there are from five to six broods annually. Further south it is known to produce as many as seven broods annually. It attacks all kinds of willows, especially the smaller ones, but seems to be more partial to the different varieties of the White and Basket willows; and, as stated by Professor Lugg, it will "in some extreme cases" even injure young Poplars as well. Young plants seem to be preferred, and consequently suffer most from the attacks of this saw-fly.

## NATURAL HISTORY.

"The rather large eggs are deposited in the usual manner by means of two saws situated under the posterior part of the abdomen, and produce little blister-like swellings, which give the leaf a crumpled appearance, as may be seen in the lower leaf illustrated in Fig. 46. The eggs themselves are oval, whitish, increase in size after being laid, and are only partly inserted into little pockets in the under surface of the leaf. As soon as the young slugs hatch, they gnaw minute holes, which increase in size in the same ratio as the slugs themselves grow. The slugs feed in company and their presence soon becomes painfully visible, they being of a slimy black color, and covered and surrounded by their filthy and moist excrement. When they grow larger they devour the whole leaf, leaving only the tougher ribs of it untouched. At first white, with a small blackish spot on each side of the head, they soon change to a shiny black, ornamented with yellow spots; a slimy matter covers their entire body. After their last moult the characteristic and conspicuous markings (Fig. 46, b) of ten large yellow spots become very prominent; their heads are perpendicular, free, and polished black. Besides the three pairs of long and black true legs, the slugs possess six pairs of light-blue prolegs, and a seventh

very imperfect pair of anal ones. The slugs, owing to their conspicuous colors and markings, are readily seen upon the plants. Like most larvæ of this kind, they assume, when at rest, the peculiar curved position of an interrogation mark. In the course of ten days to three weeks they moult four times, and reach full size, indicated by

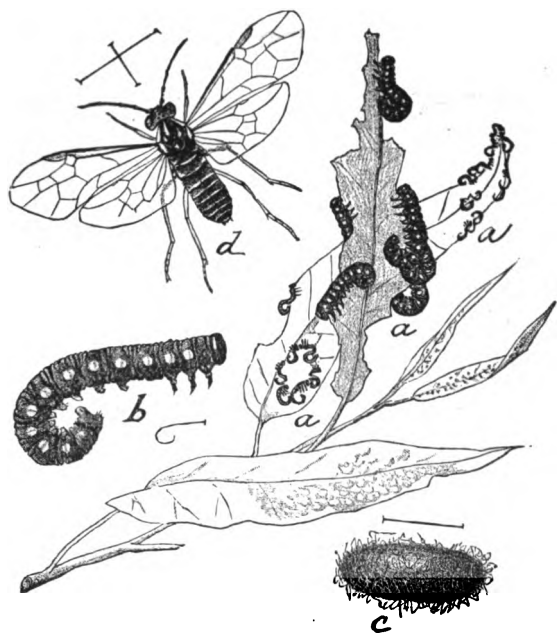


FIG. 46.—The Yellow-spotted Willow-slug (*Nematus ventralis*)  
a, a, young larvæ; b, full grown larva; c, cocoon; d, adult fly;  
all slightly enlarged. [After Howard.]

a line under Fig. 46, b. They now enter the ground and form shiny glue-like cocoons (Fig. 46, c), of a dark, almost bronze color. Within this cocoon, which consists of a rough outside layer and a smooth and tough inner one, they change to a yellow pupa, which in the course of a week may give forth the winged insect.

"The mature insect (Fig. 46, d) is very sluggish in all its motions, and the female, while engaged in sawing slits in the leaves for the reception of eggs, can be handled without greatly disturbing it. Both sexes are black; the female has the venter, tibiæ, palpi, and the base of the wings bluish-green, the edges of the abdomen and some obsolete bands between the segments pale yellowish. The same parts in the



male, as well as part of the upper surface of the abdomen, are yellowish-brown or orange colored.”\*

#### REMEDIES.

This willow-slug does not appear to have many enemies of any kind. Birds do not seem to relish it, nor is it very subject to the attack of insect parasites, which do not care to molest the slime and dirt covered slugs. Sometimes the eggs are destroyed in the Eastern States by a small Chalcid parasite; but so far I have not noticed its work here in the West. A few of the pupæ are evidently destroyed by mice, moles, and shrews, and some one or more of the numerous Tachina-flies may occasionally destroy the slugs.

Professor Lugger says “No insect is more readily combated by arsenical solutions than this *Yellow-spotted Willow-slug*, and willows devoured by it are a disgrace to the owner, indicating gross negligence or ignorance on his part.”

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### THE SYCAMORE LEAF-BEETLE.

(*Chlamys plicata* Fabr.)

While the sycamore, or buttonwood tree as it is sometimes called, is not generally cultivated upon tree-claims, it is an occasional tree thus used. When this is the case, it also suffers more or less from the attacks of insect foes. Some of these injuries are of sufficient importance to receive notice in this bulletin.

By referring to the accompanying figure, the reader will see a small leaf-beetle shown in its various stages of egg, larva, pupa and imago, together with a leaf illustrating the manner of its attack. This beetle, has been given the name of the Sycamore Leaf-beetle on account of its seeming preference for and injury to that tree. It was studied during the summer of 1886, at Manhattan, Kansas, by Mr. C. L. Marlatt while acting as assistant to Professor E. A. Popenœ, of the Kansas Agricultural College. The illustrations herewith presented are also from the pencil of that gentleman.

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\*Agricultural Experiment Station of Minnesota, No. 9, pp. 51-3. Insects Affecting Willows and Poplars, by Prof. Otto Lugger. Also, see L. O. Howard's article on this insect in *Insect Life*, Vol. I, No. 2, pp. 33-37. [August, 1888.]

The following descriptions and account of this insect are quoted from a paper by Professor Popence:\*

"In length, specimens of this insect vary somewhat above an eighth of an inch; and in color, variations occur from the light coppery or bronzed red of the newly-transformed living insect, through duller bronze, with blue, purple or green glints, to dull purplish brown. The

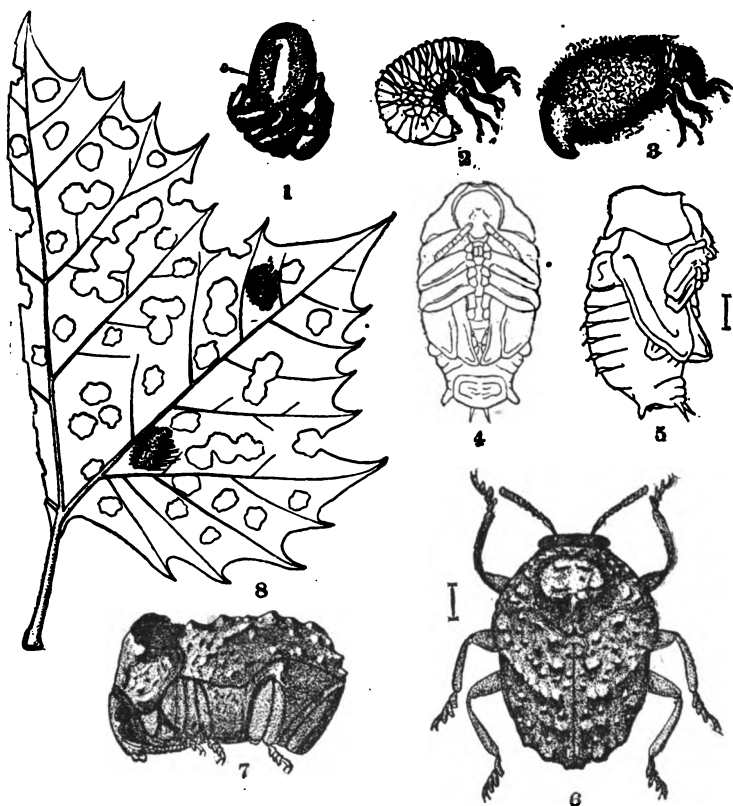


FIG. 47.—The Sycamore Leaf-beetle (*Chlamys plicata*): 1, the egg; 2, larva; 3, larva in case; 4 and 5, pupa, front and side views; 6 and 7, the beetle, seen from above and the side—all greatly enlarged; 8, sycamore leaf, showing two cases and work of larvæ. [After C. L. Marshall.]

form and proportions of the beetle, and the striking and characteristic sculpture of the thorax and elytra, are shown in No. 6 (from above) and 7 (from the side) on Fig. 47. \* \* \* \*

"The eggs, one twenty-fourth of an inch in length, red in color,

\*First Annual Report Kansas State Experiment Station, pp. [ ].

are found singly upon the midrib of the leaf, upon its under side, set like an acorn in its cup, in a brownish excrementitious mass as shown in the figure at No. 1. The natural size is indicated approximately by the small figure connected by a dotted line at the left.

"The larvæ, when full-grown, measure about one-fourth of an inch in length; are short-curved, six-footed grubs of a general pale-yellowish color, with the head, legs, shield on first segment, and a space above the bases of second and third pairs of legs, dark-brown or blackish, polished; the body is sparsely hairy, more especially upon the anterior portion. The larva is a case-bearer, and carries about with it, from the time of hatching, a thick, blunt, white-downy, protecting case, constructed of its own castings and covered apparently with the tomentum [fuzz or down] from the under side of the Sycamore leaf. This case is, from time to time, enlarged to suit the needs of the growing larva, and when the latter is mature, its case, now about one-quarter of an inch in length, serves further, when glued mouth downward upon some smooth surface, as a protection for the insect during its helpless pupal existence."

#### LIFE-HISTORY AND HABITS.

Like the majority of the species of the family to which this beetle belongs, it lives upon the foliage of several kinds of plants besides the one now under consideration. It is a strong flier, and at times quite a traveler, making long journeys on the wing while in search of food and egg-laying places. There are probably at least two broods annually, the first appearing during June and July, and the second later. The beetles winter over among fallen leaves, under boards, sticks, chips, and various kinds of vegetable *debris*. Like many of its allies, this beetle is also a great feigner or "possum." Upon the least disturbance it lets go its hold upon the leaf and drops to the ground, where it feigns death. When it drops thus, its antennæ and legs are drawn up close to the body as shown at 7. In this position it appears much more like the droppings of some large caterpillar than it does a beetle.

Not only does this beetle occur in Kansas, but it is also a rather common insect throughout portions of the Atlantic and Gulf regions, as well as in Nebraska, Iowa, and South Dakota. It is not confined to timber regions, for it has been taken by me many miles distant

from any growths of either natural or cultivated trees, where it was found wintering under cattle droppings in company with various other prairie inhabiting insects. It has also been collected by beating the Shoe-string (*Amorpho canescens*), upon which it may also be found.

#### REMEDIES.

Case-bearers, as a rule, are pretty well protected from insect enemies as well as from birds. So with the present species we need not depend upon outside agencies entirely when we wish to get rid of it. Being exclusively a leaf-eating insect, it can be very readily destroyed upon young trees, which, by the way, suffer most from its attacks, by spraying the trees with London purple or Paris green at the time when the larvæ are most at work. Number 8 in the figure (Fig. 50) shows the appearance of a leaf as it looks when riddled by this insect. Sometimes young trees have most of the leaves injured fully as much as the one shown here. When such is the case, the effect upon the tree is quite evident.

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### THE COTTONWOOD LEAF-BEETLE.

(*Lina scripta* Fabr.).

Any insect enemy or enemies of the cottonwoods and willows would naturally attract the attention of the settler here in the West. Especially would this be true in the states of Kansas, Nebraska, and the two Dakotas, where these trees form so important a factor in the timber supply of the country. The cottonwood, poplars and willows are the only trees, or indication of timber growth, that will or are to be met with for many miles in some portions of this region.\* On the homestead, tree-claim, farm, in the village, the larger towns and even cities of these prairie states the cottonwood is usually one of the first if not the only tree to meet our gaze. An insect, therefore, that injures these trees, as inferior as they are, very quickly attracts the attention of those most interested. Especially is this true when such an insect enemy appears in numbers sufficiently great to become injurious. The Cottonwood Leaf-beetle certainly comes within the category of insect pests, and as a tree-claim defoliator stands at the head of the list.

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\* Quite recently, within the past four or five years, these trees have been replaced to some extent by other kinds.

As early as 1875, Professor Snow, of the Kansas State University, wrote upon the subject of this insect's devastations in that state.\* About three years later Prof. C. V. Riley, who at the time was engaged, in company with several other entomologists, in the investigation of the Rocky Mountain Locust plague, furnished quite an extended history of the Cottonwood Leaf-beetle and its injuries in the West for the *New York Weekly Tribune*. His article appeared in that paper in the issue for October 9, 1878.

As the name implies, this insect belongs to that extensive group or order of insect life known as Coleoptera, or beetles. It is classed in the same family with the Colorado Potato-beetle, the Chrysomelidæ or leaf-beetles, and like the last-named insect is a leaf-eater—feeding on the foliage both in the larval and perfect stages. It feeds upon the younger and more tender leaves and twigs, and thereby causes the tree to die in the course of time, if the attack be continued several years in succession. When the beetles are very numerous, all the leaves are eaten, and even the tender bark upon the new growth is devoured also. When such is the case the twigs turn black, shrivel up, and die. I have seen whole groves thus destroyed in a few weeks by this insect. Trees killed by the Cottonwood Leaf-beetle have the appearance of having been injured by "fire blight." The twigs and remnants of undevoured leaves turn black and shrivel up. The beetle is more highly favored on elevated, somewhat arid, ground where the tree-growth is small and the temperature is low, than on the low ground where the conditions are the reverse, though it often thrives for a time even here. Rank growth in a tree thus attacked is a disadvantage for the insect, and trees of this nature are seldom, if ever, killed by it. I have invariably noticed that this beetle is most commonly met in injurious numbers upon the high dry plains of the West lying east of the Rocky Mountains.

#### DESCRIPTION.

*Imago*.—The beetle is brightly colored above with yellow and black, and sometimes with a reddish tinge along the edges of the elytra and thorax. The thorax is black, bordered with yellow, with two small, black dots as in the illustration. The elytra, or wing-covers, are yellow or greenish-yellow, marked with black streaks and blotches ar-

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\* Observer of Nature, Lawrence, Kas., November 23, 1875.

ranged as shown in Fig. 48, *a, b, c*; the legs are yellow or yellowish-brown, marked with black; and the entire lower surface of body deep bluish-black. In some portions of the country inhabited by this insect, individuals occur that are uniformly deep bluish-black throughout. Other specimens vary greatly in the prominence or absence of



FIG. 48.—The Striped Cottonwood Leaf-beetle (*Lina scripta*), showing variations in its markings. [After Riley.]

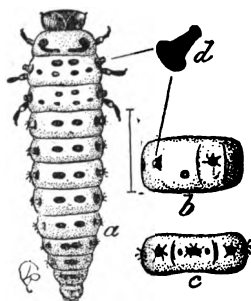


FIG. 49.—Larva of *Lina populi*: *a*, dorsal view; *b*, side view of one of middle joints; *c*, ventral view of same; *d*, one of the secreting tubercles—all enlarged. [After Riley.]

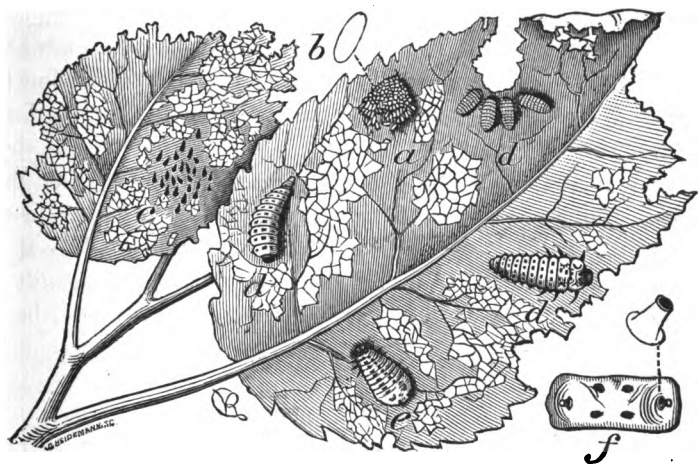


FIG. 50.—The Striped Cottonwood Leaf-beetle: *a*, eggs; *b*, one enlarged; *c*, newly-hatched larvæ; *d, d, d*, larvæ of different sizes; *e*, pupa—natural size; *f*, one of middle joints of body of larva, from above, showing tubercles—enlarged. [After Riley.]

the dark markings upon the elytra. In fact, so variable is it in this respect, that were it not so common, these different forms of coloration might form the types of distinct species.

*Eggs.*—The eggs of the Cottonwood Leaf-beetle are elongate-oval bodies measuring  $0.5^{\text{mm}}$  in length; in color they are pale yellowish-white, rather soft, and are laid upon the leaves of the food-plant in clusters. One of these clusters of the eggs is shown in the accompanying illustration (Fig. 50) at *a*, and in the same figure one of them magnified at *b*.

*Larva.*—When first hatched the larvæ are nearly or quite black, but with each successive moult they become lighter. The mature larva, "color dingy, yellowish-white; head and legs polished black. Venter with three rows of dusky, highly polished spots becoming confluent on joints 11 and 12, the middle row double but confluent. On joints 2, 3, and 4 the outer rows are represented by a mere speck, and on joint 1 they are obsolete. Laterally there are two rows of somewhat darker, more elevated tubercles, the upper row the largest, the lower one obsolete on thoracic joints. Dorsally there are four distinct rows, the outer rows consisting of distinct tubercles, from the tops of which a milky fluid can be thrust. On joints 2 and 3 these tubercles are somewhat lower down than on the other joints, and raised on a bulbous swelling, and the intermediate space between them and the medio-dorsal tubercles is smaller and paler than the rest of the body, and surmounted by two or three quite minute dusky specks. The stigmata are black, the first pair on a fold which seems to belong more to the second than to the first joint, the others normally placed between the upper lateral and lower dorsal tubercle. Pseudo-pod, pale."

*Pupa.*—The pupa is formed partially within the larval skin, which is attached to the leaf in a similar manner with those of the Coccinellidæ (lady bugs). It is spotted in very much the same way as the larva, and is rather short and broad as shown in Fig. 50, *c*.

#### NATURAL HISTORY.

The perfect insects in fall, after the first heavy frosts, leave the cottonwoods, poplars and willows where they had been feeding, and seek some shelter. They hibernate in sheltered positions under all sorts of rubbish and vegetable *debris*, under boards, chips, bits of bark, and even the droppings of cattle and horses. As soon as the leaves of these trees upon which they feed begin to unfold in the spring, the beetles are astir. Leaving their winter quarters they seek these new growths, begin feeding, mate and lay their eggs. The eggs, which are laid in

clusters like those of the Colorado Potato-beetle, but which are of a paler yellow color, hatch in the course of five to eight or ten days, varying according to the time of year and state of the weather. The larvæ when first hatched are small, elongate, almost black grubs that feed in company. In the first stage they feed upon the parenchyma and skeletonize the leaves; but later on in life they scatter and feed independently. After the larvæ have passed their second moult, they begin to eat large holes into the leaves, and when very numerous entirely consume them except midribs and larger veins. They grow very rapidly, pass through several moults and finally, upon maturing, they fasten their hind legs firmly to the leaf and partially moult their larval skin, and change to pupa. The pupa is shown at Fig. 53, *e*. There are at least three broods of the insect annually in the Dakotas and Minnesota, while farther southward as many as four or even five have been known to occur under favorable conditions. In Nebraska and northern Kansas there are either three or four of these broods—some years the one, and other years the other number. Late broods often occur when the trees make a secondary growth. The larva of this beetle, like those of all the other species of the genus *Lina*, possesses the power to emit a milky, somewhat pungent, fluid from the tips of the tube-like spines which adorn their bodies. The structure and position of these tubes is shown in Fig. 50 at *f*, somewhat magnified. The larvæ have the power of reabsorbing this fluid when it is not rubbed off by coming in contact with some foreign body. By touching the larvæ with a small stick or disturbing them, one can easily cause them to exude this fluid. If one is careful, he can observe the small globular drops of the fluid increase or decrease in size at will, by simply touching or withdrawing the stick from the larva's body. I have had a larva continue the operation of expelling and absorbing this fluid for fully fifteen minutes, without appearing to lose any of its powers. This fluid is a safe-guard for the larva against insect and other foes.

#### CAUSES OF INCREASE.

Usually insect depredations follow a change in the supply or diminution of the food-plant attacked. When the willows and cottonwoods that grew along the banks of the Missouri river had been attacked with vigor by the settler who used these trees for fuel, shedding, and homes for themselves, the *Lina* or Leaf-beetle for some



unaccountable reason took to traveling. Small groves had been planted upon the prairies miles away from the rivers, and the trees were eagerly sought by the traveling beetles. These went to work and laid their eggs, they hatched, the larvæ grew and matured, and in turn reared fresh broods, which, being far removed from enemies, flourished amazingly. This same thing was repeated in other directions so that the beetle became quite generally distributed over the country within twenty to forty miles of the place of origin. When the timber culture law was passed, the opening up of new territory was greatly extended by the thousands who took advantage of this law to gain homes for themselves and families. Trees had to be planted, the sandbars along the Missouri and its tributaries were covered with millions of young cottonwoods and willows that could be had for the pulling. These were accordingly taken and carried to all points of the compass and planted. They grew and thus were started new homes, both for settlers and for the chance straggler in the shape of insects also in quest of homes. The foliage of the small trees was tender as well as nutritious, and all was well. The trees were cultivated, but the few "bugs" upon the foliage were left to go unmolested. The second and third summers passed in like manner; but by the middle of the fourth the trees were so completely covered with the beetles that injury was inevitable. But few of the "lady-bugs" had followed the leaf-beetles, and hence they had been left unmolested.

During the first few years after planting, the cottonwood has but few limbs and is comparatively slow in growth; and more especially is this the case upon uplands where the supply of moisture is somewhat restricted.

#### DISTRIBUTION.

The geographical distribution of the Cottonwood Leaf-beetle is wide. It occurs throughout the great interior basin from the Alleghanies to the Rockies and beyond. I found it quite abundant on the Saskatchewan in 1883, and it is reported from as far south as Louisiana and Texas, while in California and Oregon it is a well-known insect. Its center of distribution, however, appears to be along the Missouri river in the states of South Dakota, Nebraska, and Kansas; and it is in these three states that the greatest injuries have been sustained.

## OTHER FOOD-PLANTS AND FORMER INJURY.

Under this heading Professor Riley writes as follows:\*

"This species has long been known to feed upon the leaves of the different species of willow, but upon those trees it was never remarka-



FIG. 51.—The 9-spotted Lady-bird (*Coccinella 9-notata*). [After Riley.]



FIG. 52.—The 13-spotted Lady-bird (*H. 13-punctata*). [After Riley.]

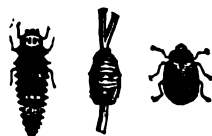


FIG. 53.—The Convergent Lady-bird (*Hippodamia convergens*): larva, pupa, and imago or beetle. [After Riley.]



FIG. 54.—The Spotted Lady-bird (*Megilla maculata*). [After Riley.]



FIG. 55.—Lady-bird larva. [After Riley.]

bly abundant or injurious. Upon several of the species of *Populus* it was also found, but its great liking for Cottonwood seems to be of comparatively recent acquirement;" and in speaking of this change of habit, he remarked as follows in the article in the *New York Weekly Tribune*, already referred to:

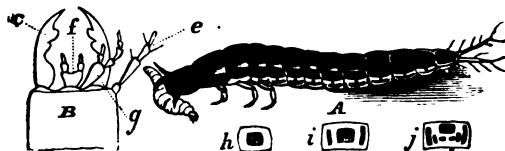


FIG. 56.—Larva of Ground beetle (*Harpalus pennsylvanicus*). [After Riley.]



FIG. 57.—Ground beetle (*Harpalus caliginosus*). [After Riley.]

"The interesting feature about this insect to the forester, however, is that it has of late years acquired an especial liking for the Cottonwood. It has, indeed, become a most grievous pest in the prairie

\* Report United States Department of Agriculture for 1884, p. 337.

states, where the cottonwood is largely grown as a shade and ornamental tree, as well as for fuel. We have been surprised, in passing through Kansas and Nebraska more particularly, at the utter devastation which this beetle has produced. Vast groves have been destroyed through its incessant defoliation."



FIG. 58.—Elongated Ground beetle (*Pasimachus elongatus*). [After Riley.]



FIG. 59.—Ground beetle. [After Riley.]



FIG. 60.—Six-spotted Tiger beetle (*Cicindela 6-guttata*). [After Riley.]

In some portions of the Sand-hill region of Nebraska this insect is equally destructive to the foliage of the White Willow hedges. This latter tree does not, however, appear to suffer so quickly from several successive defoliations as does the cottonwood.

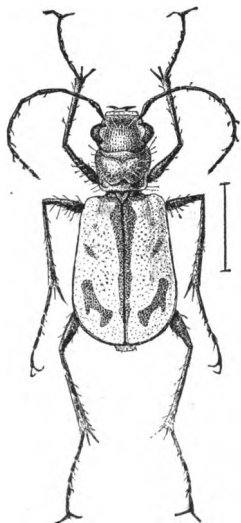


FIG. 61.—The Bordered Tiger beetle (*Cicindela limbata*). [From Insect Life.]



FIG. 62.—The Pictured Soldier-bug (*Perillus claudius*). [Original.]



FIG. 63.—The Spined Soldier-bug (*Podisus spinosus*). [After Riley.]

## REMEDIES.

Unlike most of our other insect pests the Cottonwood Leaf-beetle has but few natural enemies, hence we can hope for but little aid from these. Thus far no reports have reached me of any of the insectivorous birds eating it. We have to thank our little friends, the lady-birds, for the aid they give here. Such of them as are known to destroy the Colorado Potato-beetle also feed upon the eggs and very young larvæ of this beetle. Its battery of offensive secretory glands is too much for all other insects to endure! Some of these friendly lady-birds, with several other predaceous insect enemies of this beetle, are herewith illustrated (Figs. 51 to 63).

We have a direct remedy in nature, however; and that is in wet seasons. During such seasons the insect never appears to do serious damage. Often when quite abundant the arrival of a wet "spell" will greatly reduce their numbers.

Inasmuch as this beetle undergoes all of its transformations upon the leaves of the tree it is very easy for us to destroy it with the use of any of the arsenical sprays. Either the London purple or Paris green. These can be applied quite rapidly as well as effectively with any good force pump and spray-nozzle. Three to four ounces of the poison to a barrel of water (45 gals.) is plenty strong. Care should be taken not to allow horses to feed upon the trees after spraying, as there is danger of their being poisoned also.

## THE SPOTTED COTTONWOOD AND WILLOW BEETLE.

(*Lina lapponica* Linn.)

The spotted beetle, shown herewith (Fig. 64) in several of its variations, belongs to the same genus with the one just described; and like that species also attacks the cottonwood and willows here in Nebraska. Until within a very few years, not more than three or four, this species of *Lina* was considered quite rare and only occurred upon the willows.



FIG. 64.—The Spotted Cottonwood Beetle (*Lina lapponica*). Showing the variation in the markings. Slightly enlarged. [Original.]

Last summer, however, it was very common, in fact plentiful; and in some localities visited by me it was equally as numerous as

the *Lina scripta*, which did great injury to both the cottonwood and willows. Like that insect, it was also found feeding upon both kinds of trees, and seemed to relish the one as much as the other. This habit of working upon the cottonwood appears to be growing upon the spotted beetle, since it formerly plainly preferred the willows—especially the larger kinds.

The larvæ of the two species are very similar and, as Professor Riley says, are scarcely distinguishable on the most careful comparison. He writes:\* “In meeting with the larvæ of the two commoner Western and Southern species here mentioned, we have often endeavored to ascertain whether they possess any differing characters that would permit us to decide positively which species of beetle they would produce, and after a good many comparisons both of the living and preserved larvæ, we have concluded that there are no differences that can be positively relied on. The latter species [*Lina lapponica*] emits the milky fluid more freely and has perhaps a more pungent odor.”

The imagos of the two species are quite easily distinguished apart. The *lapponica* is red spotted with black, and at first glance might be mistaken for one of the lady-birds, only for its larger size and more elongate form. Like the other species of the genus it is very variable, some specimens having no markings whatever upon the elytra, others have but two spots near the middle of each (Fig. 64, c), while in some the spots are very heavy and run together.

As nearly as I have been able to ascertain, the Spotted Cottonwood beetle is not as many brooded as is its near ally, the Striped species, there being possibly but two, or at most only three, broods annually here in Nebraska.

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## THE WILLOW LINA.

(*Lina* ——— sp.)

A third species of *Lina* that is quite common in the Sand-hill region of Nebraska is the one shown in Fig. 65. This last named insect, so far as I am at present aware, has only been found feeding upon a single species of willow—the little or dwarf willow (*Salix humilis*) which grows in patches upon north hill slopes. This beetle

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\* American Entomologist, Vol. III, p. 161. [1880.]

bears a rather close resemblance to *Lina scripta*, but differs from it in being shorter, plumper, and slightly broader; in having a broader thorax, which is usually of a uniform rufous color. This last species has the markings as in the figure, which shows an average specimen. Others occur in which the marks are much heavier, while still others have them almost obliterated. The thorax is usually without marks, but in some a few dark spots occur near its middle.



FIG. 65.—Willow Leaf-beetle near *Lina scripta*. [Original.]

## THE LARGE YELLOW AND BLACK SWALLOW-TAIL BUTTERFLY.

(*Papilio turnus* L.)

One of our commonest and, at the same time, most attractive injurious insects here in the West is the one shown in Fig. 66. It is what is generally known to the people of the country as the Large

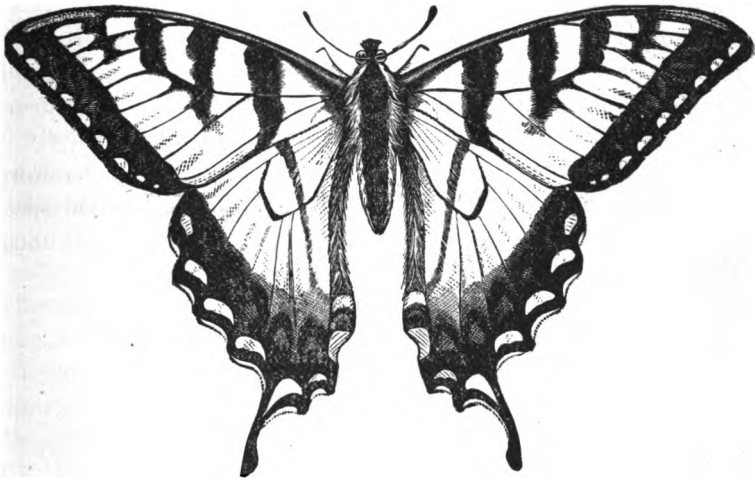


FIG. 66.—*Papilio turnus*. [After Saunders.]

Yellow Swallow-tail Butterfly, although very common and everywhere present, but few of our people know anything about its food-habits and life-history aside from its existence as a gaudy butterfly that frequents flowers and sometimes flits about our door yards. Some

of my readers will perhaps be a little surprised, therefore, to learn that this and the following butterfly are quite prominent among our tree pests. This insect is not habitually a pest, but very frequently becomes sufficiently numerous in certain localities to completely defoliate isolated small trees, and once in a while even to badly damage



FIG. 67.—Larva of *P. turnus*. [After Saunders.]



FIG. 68.—Pupa or chrysalis of *P. turnus*. [After Glover.]

whole groves of such trees. An instance of this kind came to my notice several years ago. A Mr. Copeland, of Antelope county, Nebraska, sent me specimens of the larva, together with a statement that it was stripping all the leaves from his small ash grove growing upon a tree-claim. Other references could also be given of this insect's injury to small trees upon tree-claims and homesteads, as well as to those growing in older settled districts. The ash is not the only tree upon which the caterpillars of this butterfly feed. Far from it! Mr. S. H. Scudder, whose writings I will quote quite extensively further on, gives a list of nearly fifty different food-plants for it. Among these he mentions cherry, plum, apple, peach, basswood, birch, catalpa, willow, cottonwood, etc.

The butterfly need not be described very minutely, for the illustration will be sufficient to enable its identification. The butterfly is yellow and black when typical; but over the greater portion of the United States there is a dark form of the female. This latter is almost black, and in some localities outnumbers the yellow examples. The males are always of the typical color. In addition to the yellow and black colors there are blue, orange and red markings upon the posterior portion of the hind wings. These markings occur upon both the yellow and dark forms.

In early spring, when the wild plums and cherry trees are in bloom, these swallow-tail butterflies are to be seen hovering over and about the blossoms of these trees, often in considerable numbers. Later in

the year, usually in midsummer with us, they gather about mud holes or on moist ground like other butterflies, and sometimes in large numbers too. Here in Nebraska there are two broods annually, the larva of the first maturing so as to issue as imagos late in July or early in August. The second brood invariably pass the winter as chrysalids, and issue with the opening of fruit blossoms in May. The eggs are laid, to the number of from 150 to 200 for each female, upon the upper surface of the leaves of trees, usually small ones, of the kinds selected as food for the larva. These are scattered about singly upon different trees, usually but a single one to a tree. They are about 1.4<sup>mm</sup> in greatest diameter, green when first laid, but becoming mottled with age so as to give them a brownish-yellow color before hatching. They hatch in about eight to twelve or fourteen days.

The larva when first hatched, and, in fact, during the entire period of its earlier existence, differs materially from the mature or full-fed caterpillar as shown in the accompanying illustration. It is at first velvety black, more or less varied with greenish-white and purple, and has the body of nearly uniform size throughout. Later on, the front portion of the larva becomes enlarged or swollen; the color changes somewhat, and the size of the light colored dorsal patch varies, as does also its shade and form.

#### HABITS OF THE LARVA.

"When young, the caterpillar bites deep excavations out of the edge of the leaf opposite to the spot where it rests, weaving a bit of carpet on another part of the leaf, to which it retires when not feeding, and arches its body, when quite young, much after the style of *Sphinx larvæ*, as if impatient to assume the swollen form of the anterior part of the body which belongs to its maturer life! As soon, however, as it has moulted once, sometimes before moulting, it retires to a fresh leaf and there weaves a new carpet, generally in the middle, but if the leaf does not droop so as to enable it to rest on this carpet in a vertical or nearly vertical position, it chooses a vertical part of the leaf and rests here, head upward, so that all excrement falls to the ground and the carpet remains clean. It feeds both by day and by night, but it does not now eat the leaf that it rests on, but goes off every few hours for a dinner on another leaf, and indeed the same leaf it has



dined on before, always finishing one, on repeated visits before attacking another.”\*

The larva is provided with a forked orange colored apparatus, which is habitually kept concealed within the front edge of the segment just back of its head, which it can eject or throw out, and at the same time emit an offensive odor. This peculiar organ of offense or defense, as the case may be, can very readily be seen by any one who will take the pains to disturb the larva when at rest.

The mature larva (Fig. 68) is described as follows by Scudder (*loc. cit.*, p. 1293):

“Head delicate ferruginous, mottled below, and especially at the sides, with pale; lower part of triangle, pale, antennæ pale; tip of third joint fuscous; ocelli black in a black field; labrum pale; mouth-parts pale, the tip of the mandible reddish. Body nearly uniform, rich deep green, paler below the spiracles, specked throughout with indistinct pale dots, which on the sides sometimes become confluent, and form faint, linear, irregular streaks, having a general direction from below backward and upward; faint streaks also radiate from the spiracles; a narrow yellow stripe, bordering the osmaterial [scent organ] fold, sometimes extends backward, forming a stigmatal line across the thoracic segments; third thoracic segment with rather a large, lateral, subquadrate greenish spot, delicately but distinctly edged with black, and having within it above, a black streak, and centrally a small turquoise spot broadly annulated with black; upper surface of the first abdominal segment edged posteriorly with yellow, and the second anteriorly with black; fourth abdominal segment with a lateral, anterior, broadly oval, oblique, salmon colored spot, sometimes obsolete, extending slightly on the succeeding segments; the papilli form warts of the eighth abdominal segment and superior portion of the transverse fold on which they are seated, lemon yellow, sometimes green; the first, second, fifth to seventh abdominal segments, with a laterodorsal and lateral row of small, circular, dark turquoise or pure blue spots, those of the posterior segments faintly rimmed with fuscous; the lateral spots of the third thoracic segment are in the yellowish spot already described, and the laterodorsal ones are just above; third to eighth abdominal segments with an infrastigmatal row of pale turquoise spots, smaller than the others, centrally placed; under sur-

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\*Scudder, *Butterflies of Eastern United States and Canada*, p. 1292.

face of the body, pale green. Body very sparsely covered with very delicate short hairs; osmaterium dark orange; spiracles tuteous. Legs pale green, claws, fuscous. Prolegs pale green. After the evacuation preceding pupation, the larva becomes of a dull, dirty, velvety green on the thoracic and first abdominal segments; posteriorly it is grizzly green, laterally streaked with fuscous. Length, 50<sup>mm</sup>; greatest breadth, 10<sup>mm</sup>; breadth behind, 4.5<sup>mm</sup>; breadth of head, 4<sup>mm</sup>."

The chrysalis is formed in some sheltered place, often quite a distance from where the larva fed. It is suspended by a silken thread or loop which is thrown about its body, as seen in Fig. 71. In color it is dull yellowish-gray, more or less streaked and flecked with brown and dull black. In summer, for the first brood, this stage lasts from two to three weeks; while, as has already been stated, the insect invariably winters in this stage.

#### INSECT AND OTHER ENEMIES.

In treating of the enemies of the Yellow Swallow-tail, I can do no better than to quote from the writings of such authors as Wm. H. Edwards and S. H. Scudder, our two best authorities on North American butterflies. Mr. Edwards writes: "Turnus has many enemies, birds and dragon flies by day, and probably small owls and others by night. In spite of their expanse of wing and power of flight, the larger Libellulidæ will pounce on them in mid-air and carry them away. On several occasions I have known this to happen. I scarcely ever go into the garden of a midsummer morning that I do not see severed wings of Papilios and of some of the large bombycid moths upon the ground, and can only account for so much destruction at night by crediting it to the owls, which are not at all uncommon. The eggs are always liable to discovery by spiders and ants; and when the larvæ do emerge, some are destroyed by the same foes; others are stung by Ichneumon flies, and either while larvæ or in chrysalis inevitably perish. And when at last a chrysalis is formed, it is exposed to peril from new enemies, squirrels, mice, birds, and one would think few could possibly survive the long months of winter with such a risk of destruction."\*

Scudder adds to these words: "To Miss C. Guild, of Walpole, Mass., is due the sole credit of first bringing to light, in 1869, an in-

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\* Butterflies of North America, Vol. II.

Interesting egg parasite (*Trichogramma minutissimum*) the first one which had then been known to me to attack the eggs of our butterflies. By her careful and patient examination of the leaves of young birch trees, she found a number of eggs, and among them five or six which had been attacked by this parasite; they could be instantly recognized, because they had all turned of an inky black color. From the first eggs some specimens were probably lost. They made their appearance the last of June, and eighteen specimens were obtained. Subsequently Miss Guild brought me five more eggs, which had been inclosed in a tight box and in which the specimens were all dead. Miss Guild thought that none had escaped, and I counted seventy-nine specimens (nine male, seventy female), making an average of sixteen to each egg. The parasites escaped by eating their way out of a minute, nearly circular hole in the side of the egg, measuring .25<sup>mm</sup> in diameter.\*

"It has also long been known that the caterpillar is stung by *Trogus acesorius*, the perfect insect finally escaping from the side of the upper half of the chrysalis. Mr. E. Norton, of Farmington, Conn., has also bred another hymenopterous parasite, *Copidosoma turni*. Mr. Riley's notes state that in 1871 he had bred two kinds of parasites from the pupa; and some chrysalids I obtained at Moosehead Lake, in Maine, gave me a dipterous parasite, *Mascicera frenchii*."

Should these enemies not prove sufficient to keep the insect in check the remedies suggested for controlling other caterpillars will be found quite effectual. Hand picking in cases where but a few trees are to be protected will not be tedious, and would certainly be better than to allow the trees to be defoliated.

## THE ANTIOPA OR YELLOW-BORDERED PURPLE BUTTERFLY.

(*Euvanessa antiopa* Linn.)

When we see the beautiful purple butterfly with yellow bordered

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\* In treating the enemies of the Fall Web-worm, one (*Telenomus bifidus*) is there described as attacking the eggs of that moth, an individual of which lives and matures in a single egg. We now have one of these insects to consider which is so small that a dozen or more of them are bred from a single butterfly egg. This minute egg parasite, *Trichogramma minutissimum* Packard, ranges from one-quarter to one-half of a millimeter, or from one one-hundredth to one one-fiftieth of an inch in length. Its body is of a uniform pale yellow or honey-yellow color, with the legs and antennæ scarcely paler than the body.

wings that is shown in the accompanying illustration (Fig. 69) gaily flitting about our door yards in early spring, midsummer, and late

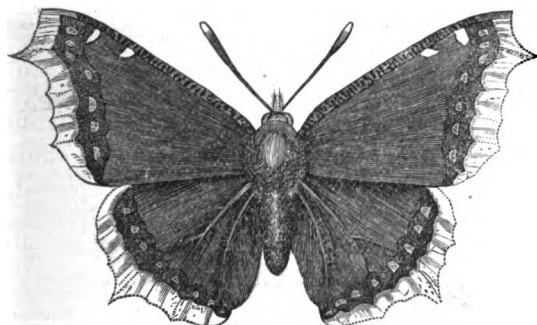


FIG 69.—*Euwanessa antiopa*. [After J. G. Wood.]

fall, little do many of us suspect its relationship to the large clusters of black spiney caterpillars with red markings on their backs, that so frequently strip our willows and elms of their leaves. Yet, by carefully watching the lat-

ter, it will be found that they develop into this same kind of butterfly.

This insect is usually supposed to be a timber-loving species, yet last summer, while spending my vacation in the sand-hill region of central and western Nebraska, I was much surprised to find its larvæ by the thousands upon the small willows that grew in clumps along the streams of that portion of the state. During other seasons these same larvæ were also observed at other localities in the state, equally far removed from the natural and planted groves along the larger streams and in older settled districts.

The butterfly certainly is a strong flier to be able to reach these localities so far removed from where it must have passed the winter, since it could hardly have hibernated in these treeless, houseless, rockless regions, as will be shown presently. It is truly one of the ruggedest of insects, since it is one of the most widely-distributed of insects found in this country. It also occurs throughout the temperate regions of both Europe and Asia. Scudder says: "It is found in nearly equal abundance through all parts of New England, flies to but does not breed on the highest summits of the White mountains, and is nearly everywhere so numerous as to become positively injurious on account of the damage done to some of our choicest ornamenta trees. \* \* \* \* The butterfly may be found nearly everywhere, but is especially abundant in the neighborhood of woods, where it sports in sunny nooks, and in springtime may be seen 'hovering in numbers about the sappy stumps of recently cut trees.'"

## LIFE HISTORY.

The *Antiopa* butterfly is double-brooded here in the West as it is known to be also over the greater portion of its range within the United States as well as in European and Asiatic countries. Unlike most of our other butterflies *antiopa* hibernates as a perfect insect, *i. e.*

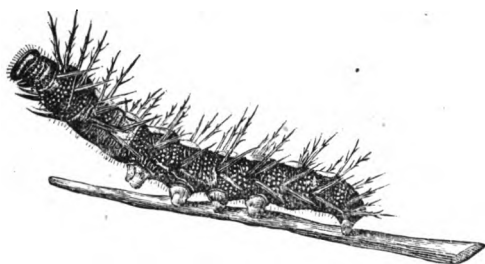


FIG. 70.—Mature larva of *Euvanesa antiopa*. [Engraved after Scudder.]



FIG. 71.—Chrysalis of *Euvanesa antiopa*. [After Harris.]

as a butterfly and not as a chrysalid [Fig. 71]. It is therefore one of the first, if not the first, butterfly to be seen in early spring—yes, even in winter should there be a few quite warm days, now and then a straggler is occasionally to be seen joyously flitting about as if enjoying the warm sunshine. It usually finds a refuge in crevices among rocks, under loose bark about old trees or even in out-buildings, etc., where it hides to pass the long cold winters. But just where it manages to hide away upon our prairies is a mystery to me. The eggs of these hibernating females are laid during the month of May, so that the larvæ disclosed from them can mature to butterflies by the first or second week in July. The July butterflies soon lay their eggs—each female at least 200—which hatch in about ten days, the larvæ maturing during the latter part of August and early in September, and issuing about two weeks later as butterflies. These fall butterflies hover about until cold weather approaches, when such of them as are still alive seek winter quarters. By the time the following spring arrives only a very small proportion of the insects that matured from the second brood of caterpillars are left. These mate and egg-laying follows, as mentioned above. The eggs, which are laid in clusters something similar to those of the Apple-tree Tent Caterpillar (*Clisiocampa americana*)—Fig. 15, on page 27, near the tip of a twig, sometimes number as many as ninety or more to the cluster. They are, when laid, pale olivaceous yellow, changing to a brownish, and just before hatch-

ing, to an inky black. The habits of the caterpillars are described as follows by Scudder: \*

"In hatching—an operation which often consumes half a day—the caterpillars bite the shell only around the outer edge of the summit, sometimes leaving the prominent ribs until the last, and, when only one or two are left, force up the lid thus formed, usually tearing it quite off in their exit. They do not eat the forsaken shells, but, moving rapidly off, seek a leaf, upon which they at once range themselves side by side in compact rows, their heads always thereafter remaining together at the edge of the eaten leaf. If placed separately upon the same leaf, they immediately arrange themselves side by side. When young they eat only the parenchyma; afterwards they devour the whole leaf excepting the principal veins; finally all but the mid-rib. They spin a sort of thin web \* \* \* enclosing the whole twig (but not the leaves) upon which they are feeding, nor ever leave this carpet nest until the branch is stripped of its leaves, when they remove to a neighboring twig. They are generally found high up in the tree and remain social throughout their caterpillar life; for, although the leaves of the trees on which they feed cannot support a row of the full-grown caterpillars, they are still found in the closest possible proximity, following each other's footsteps, the branches upon which they are clustered borne down by their united weight. Their progress on a tree may sometimes be traced by the clusters of cast-off skins they have left in their track, the first on a leaf-rib, the others on a stem of one of the twigs; for they crowd together at the time of ecdysis as at others, and as they undergo their changes, at least the earlier ones, at nearly the same time, these clusters of cast-off skins (which they never eat) remain to mark the steps of their progress. When the caterpillars have finished a repast, they retire to the stripped twigs and leaf-stalks for a siesta, where they place themselves almost invariably head downward and remain immovable for a long while, their heads and first thoracic segment a little raised, so that the front pair of legs is lifted from the twigs and directed forward, while the body hangs from the other legs and prolegs, which thus have a backward direction."

The mature caterpillar is described by the same author on page 401 of his book just referred to:

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\* Butterflies of the Eastern United States and Canada, pp. 404, 405.

“*Last stage*.—[Fig. 70.]—Head dull, bronze black, the warts black, giving rise to white hairs, arranged to some degree in vertical rows converging toward the summit of either hemisphere; mouthparts black. Body velvety black, covered with white warts, often narrowly encircled with fainter white and giving rise to white hairs; the third thoracic and first to seventh abdominal segments with a large, dorsal, orange-red spot reaching as far as the inner base of the laterodorsal spines; spines bright, bronze-black, minutely wrinkled transversely, the hairs black. Legs bright bronze-black; prolegs reddish testaceous, the hooklets reddish-brown. Length, 50<sup>mm</sup> [two inches]; breadth of body, 7<sup>mm</sup>; length of spines, 5.75<sup>mm</sup>; breadth of head, 4<sup>mm</sup>.

“The exact stage of growth of this caterpillar is easy to determine, for no matter what the size may be, however fostered by abundance or emaciated by insufficiency of food, there are certain structural features characteristic of each stage. In the first stage the body is armed with hairs arising from the little warts, none of which are placed in a median dorsal series; in the second stage the body is furnished with similar hairs having an entirely distinct distribution, some of them forming a dorsal series. In the third stage the body is armed with spines, emitting little, bristly hairs directly from its sides without the intervention of spinules; in the fourth the spines are the same, but the lateral bristles are mounted on very short spinules scarcely longer than the width of the spine; while in the fifth stage the same spines bear long spinules, often one-third of their own length, with apical thorns.”

#### ENEMIES.

The caterpillars of this insect, although they are spined, are not entirely free from insect enemies. Far from it! for, in this country there are at least five and in Europe two distinct species of hymenopterous parasites that attack it. On this subject Mr. Scudder writes: “This long-spined, red-spotted caterpillar has plenty of foes. Five Hymenoptera are known to attack it in this country, and three in Europe, including one of those found also in this country. First, *Ichneumon fossorius* is said by Ratzeburg to destroy it in Europe. Next, a European species of Haplismenus, *H. terrificus*, is said by Giraud and Laboulbène to have been bred from it. Another species of the same genus, *H. morulus*, decapitates the chrysalis on this side

of the Atlantic. Then we have two species of *Pteromalus* which attack it, *P. vanessæ* and *P. puparum*, the latter found also in Europe, and the former also attacking other butterfly caterpillars. Dr. Harris reared *P. vanessæ* on August 5; and it is perhaps of this species that Harriet Keyes writes that she 'counted one hundred and forty-five little green flies' emerge from one chrysalis of *antiopa*. Dr. Harris also obtained from this butterfly a *Derostenus*, *D. antiopæ*, on September 15. And lastly Mr. C. W. Woodworth caught *Telenomus graptæ* at the White mountains, in the very act of ovipositing on the eggs.

"But it is also attacked by dipterous parasites. *Phorocera concinnata* attacks it in Europe, and in this country *P. Edwardsii* is its deadly foe." A large ground beetle, *Calosoma scrutator*, and a large species of wasp have also been known to destroy the caterpillars of this butterfly. While in wooded and stony regions the chrysalids of this and other butterflies are destroyed by chipmunks, which make a regular practice of hunting for such tidbits as these to mingle with their vegetable diet—even catching "living" and very active insects of rather large size. In Montana, during the summer of 1880, I once watched one of these little rodents while it was engaged in capturing grasshoppers, which it would carry to an old pine log, where it sat upon its haunches until it had eaten the softer portions, and then immediately scampered after another. Judging from the large numbers of legs and wings that were strewn about the log, many an unfortunate 'hopper must have been destroyed by this one chipmunk. Other rodents also have the same habits with regards to insects.

#### REMEDIES.

Hand picking in the case of this insect is quite applicable, on account of its social habits. If, however, other remedies are preferred, the arsenical sprays can be utilized to good advantage. Although covered with such formidable-looking spines (Fig. 70), these caterpillars are perfectly harmless—at any rate, they are not poisonous to the touch as many have supposed. The sharp spines may prickle a little the skin of very tender hands, but cannot poison.



## SPHINGIDS OR HAWK-MOTHS.

Prominent among the insect defoliators of young trees growing upon claims in the tree-claim region are certain large, fleshy, green larvæ or "worms," as they are more commonly called by the general public. These larvæ are the young of what are known as "humming-bird" moths, "hawk" moths, and sphingids; and are readily to be distinguished from the larvæ of the silkworms, already referred to and figured on former pages of this bulletin, by the horn or thorn that arises from the upper surface of the tail end (Fig. 72, *a*). In this instance it is truthfully a "tail" end.

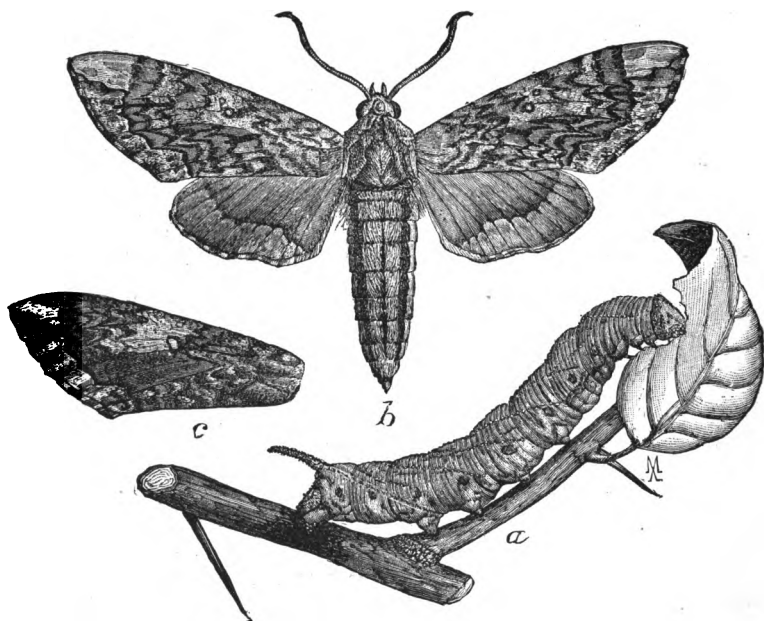


FIG. 72.—The Osage-Orange Sphinx (*Ceratomia Hageni*): *a*, larva; *b*, moth, pale or normal form; *c*, front wing of dark variety, natural size. [After Killey.]

In a recent work\* Professor John B. Smith describes eighty-three species of these moths, all of which are known to occur within the limits of North America north of Mexico. While the author does not go into the life-history and habits of the insects treated, he gives full descriptions of each species mentioned.

\* Trans-American Entomological Society, Vol. XV, April, 1888.

Here in Nebraska the ash, elm, cottonwood, willow and catalpa all suffer more or less severely from the attacks of these insects; and especially do the first two trees named come under this category. So numerous are the worms in some localities that scarcely a tree escapes without some injury at least; and I have seen hundreds of the trees entirely defoliated by them late in August and during the first half of September.

The Hawk moths, (Fig. 72, *b*) are, as a rule, rather large bodied insects, though they appear graceful rather than otherwise. Their wings are small, rather narrow and pointed. Their flight is strong and rapid; and the different species of a large proportion of them at least have the habit of hovering about and over flowers during the



FIG. 73.—Larva of Tomato-worm with cocoons of *Apanteles congregatus* attached. [After Weed.]

cooler part of the day as do humming birds. In their nature they are semi-nocturnal rather than diurnal, so that those seen about flowers are but a very small per cent of these insects that really are in a given locality. The larvæ of the Sphingids or Hawk moths, when full-grown, enter the ground and transform to dark brown pupæ without spinning cocoons. As a rule but a single brood is reared annually. Such is the case in this portion of the country at least.

While most of these Hawk moths prefer special food plants for their young, they are not necessarily restricted to regions where these plants are found growing naturally. The moths are strong and very rapid fliers and are capable of traversing great distances. Therefore trees planted a dozen or more miles away from a region in which the

insect occurs will soon be found by it and also share in providing food for additional larvæ.

Naturally, these large fleshy larvæ that are without protection are quite subject to the attacks of parasites, and not more than one in a dozen that hatch ever live to become moths. Of these parasites there are a large number of species, both hymenopterous and dipterous. One of the former (*Apanteles congregatus*) is shown in Fig. 73 as it appears spun up in its little cocoons upon the body of a Tomato-worm.

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## THE EGLANTERINA MOTH.

(*Pseudohaiza eglanterina* Boisd.)

An insect that has been increasing quite rapidly since the western half of our state has begun to settle, is the one known to entomologists by the name of *Pseudohaiza eglanterina*. So far as I am at present aware, it has no popular name other than the one which is used above. It is one of our large Bombycid moths, and is not distantly related to the silkworms treated in the first part of the bulletin. The moth, which has a wing-expanse of about two and one-half inches, is chiefly white and black, with markings of buff color about the body; and in some specimens with a faint pinkish tinge to the hind wings. The larva is about the size and has the appearance of that of *Hemileuca Maia*, the Buck Moth as it is sometimes called, and which is shown in Fig. 74. The pupa or chrysalis of *eglanterina* also resembles that of the species shown in the illustration at *b*.

The mature larva is about two and one-fourth to two and three-fourth inches in length, and is of a rich brownish black color profusely marked with bright yellow. In the stigmatal region there is a rather broad longitudinal stripe of yellow which is bordered both above and below by a narrower one of the dark color; beneath the body is purplish brown. The branched spines are large, long and very conspicuous, their basal portion being buff color while their outer portions are deep black. When handled roughly or carelessly these spines have the power to inflict rather painful stings, that produce symptoms not very different from that which ensues from contact with nettles. During the earlier stages the markings are much less

conspicuous, and the larvæ are sometimes almost entirely without them.

This larva has been received at the station several times within the past year, with the accompanying statement that they had been found feeding both upon the willows and cottonwood in great clusters; and that they had in several instances entirely defoliated the trees upon which they were found. I have also frequently seen them upon the same trees along the streams of western Nebraska, central Wyoming

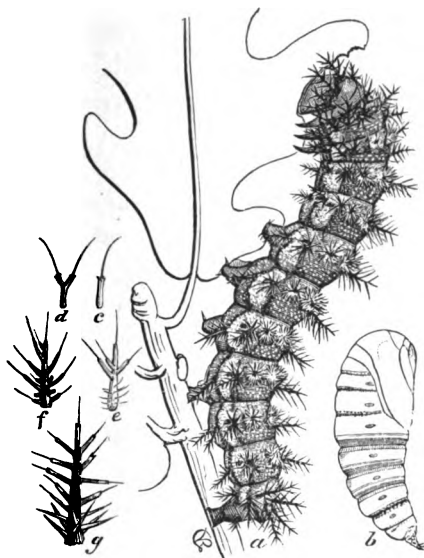


FIG. 74.—Larva of the Maia moth (*Hemileuca Maia*): b, pupa; c, d, e, f, and g, spines of larva. [After Riley.]



FIG. 75.—Eggs of the Maia moth. [After Riley.]

and southern Idaho. It has also been found feeding on the Artemesias or Sage-brush in Idaho. Wild rose is also mentioned as a food-plant of this larva.

#### LIFE-HISTORY.

So far as I am at present aware, the full life-history of this insect has never been recorded; nor am I at present prepared to give it. The eggs are said to be laid in a cluster encircling a twig in a similar manner to those of *H. Maia* which are shown in Fig. 75. Whether in the spring or fall of the year, or both, I do not know; but in all probability the fall. The larvæ that I have seen were fully matured

by the last of June and early part of July, while I have seen the moths both in June and late August. The evidence points to but a single brood annually. As the sexes were taken united late in August or very early in September, the eggs are in all probability laid in the fall and hatch the following spring after vegetation has started. The larvæ moult five times, living during their first three stages in company, but later scatter so that by the time they have become full-grown they are found single. When about to transform to the pupa stage they forsake the trees and either enter the ground or burrow among the loose vegetable *debris* and transform without spinning a cocoon.

The following description of the moth is given as published by Morrison in his "Synopsis of Lepidoptera of North America," page 222.\*

"Size and form of *Proserpina*. Upper side of primaries yellowish, white, slightly flesh color, powdered with a little blackish at the base, with the upper edge and two transverse bands black; the one near the base uniting with a large longitudinal streak of the same color; the other, near the extremity, bent, but not sinuous. Between these two bands there is a black rounded spot, or kind of eye, marked with a small whitish crescent; fringe widely black, uniting with some sagittate streaks of the same color, situated on the nerves. Secondaries of a beautiful ochry yellow, marked in the middle with a large black point in place of an eye; beyond the middle a black curved band, in a line of that of the primaries. Fringe black, forming some sagittate spots of the same color. Head and prothorax ferruginous; thorax mingled with yellow. Abdomen of the same color as secondaries, paler below and a little annulated with black. Under side like the upper. Antennæ black, pennated in the male, a little ciliate in the female."

#### REMEDIES.

The usual insect enemies (dipterous and hymenopterous) do much towards keeping this insect within bounds; while meadow mice and shrews also find and destroy many of the chrysalids. When necessary, however, on account of their voraciousness and large size, as well as social habit, the larvæ can be destroyed by hand picking. The arsenites need never be resorted to in order to check them unless they should become a very much more common insect.

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\* Smithsonian Miscellaneous Collections, Vol. IV, 1862, Article II.

## LEAF-BEETLES.

(Chrysomelidae.)

There is a very extensive family of beetles that comprises species of medium size, and under, which live upon the foliage of plants. These insects, on account of their food-habits, have received the general name of "Leaf-beetles;" and, when we take into consideration the fact that almost every species of tree, shrub and herb is preyed upon by one or more of these beetles, we may readily conceive how numerous the species must be and how diverse their tastes. Both the mature insects and their larvæ feed upon the food-plant or plants chosen by each. Some of the representatives of the family are exceeding common, and where their food-plant happens to be one of those under cultivation, the result of their attack is sometimes exceedingly damaging. Several of these leaf-beetles are among our tree-claim pests, and are treated herewith.

## THE MANY-PUNCTURED LEAF-BEETLE.

(Chrysomela multipunctata Say.)

A very common and sometimes destructive insect here in the West is shown in figures 76 and 77. It feeds upon the foliage of our different species of willows. The mature insect is shown at Fig. 76, while the larva is represented by Fig. 77.



FIG. 76.—The Many-punctured Leaf-beetle (*Chrysomela multipunctata*)—slightly enlarged. [Original.]



FIG. 77.—*Chrysomela multipunctata*: larva—slightly enlarged. [Original.]

Like the Colorado Potato-beetle, to which it is closely related, the Many-punctured Leaf-beetle feeds upon the leaves both in the larval and imago stages. The eggs are laid by the parent insect in clusters or patches both along the smaller twigs and on the leaves. These are very similar to those of the well-known insect referred to above and stand upon end arranged side by side in clusters of a dozen or more. In color they are orange-red. They hatch in from six to ten days—

of course varying in this respect according to the season of the year and state of the weather. The larvæ are light colored and marked with a row of lateral black or dark brown dots. When full-grown they measure about 10 to 12<sup>mm</sup> in length, and are transparent whitish in color. In some specimens there is a faint pinkish tinge near the middle. The mature insect is of a bright silvery yellowish-white color above with dark markings upon the elytra and a reddish-brown tinge to the upper surface of the prothorax as is shown in the illustration. Beneath it is chestnut brown with legs and antennæ of the same color. When disturbed it drops to the ground and feigns death like many of the other representatives of the extensive family to which it belongs.

There are at least two, and perhaps three, or even four, broods annually.

A well-marked variety of this beetle occurs here in Nebraska, but is present in much smaller numbers than the form just described. This latter is the *Chrysomela verrucosa* Suffr.

#### NATURAL ENEMIES AND REMEDIES.

The natural enemies of this beetle are practically the same as those that attack the Colorado Potato-beetle and the Cottonwood Leaf-beetles. These enemies, as a general thing, keep the insect under control; but occasionally when working in company with the Linas and the other leaf-beetles that attack the cottonwoods and willows they must be destroyed by some artificial means. When this becomes necessary, one or two sprayings with one or the other of the arsenical preparations mentioned in the appendix of this bulletin will effectually rid the trees of them.

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#### WILLOW FLEA-BEETLES.

In addition to the several species of leaf-beetles already described in the preceding pages, there are several others that are occasionally sufficiently numerous and destructive to small willows to warrant their being treated in this bulletin. These are what are popularly known as Flea-beetles, on account of their habit of jumping like fleas. These flea-beetles, while they belong to the same family (*Chrysomelidae*) with the other leaf-beetles, are characterized by their inflated or

swelled posterior thighs, their more elongate and somewhat flattened bodies, and by their usually bright and metallic colors.

Herewith are figured two species of these willow infesting flea-beetles, viz., the Pennsylvania Flea-beetle (*Disonycha pennsylvanica*) and the Five-lined Flea-beetle (*D. 5-vittata*). The former of these



FIG. 78.—The Pennsylvania Flea-beetle, slightly enlarged.  
[Original.]

is shown at Fig. 78, and the latter at Fig. 79. Both of these beetles occur very numerous throughout the district embraced by the tree-claim region, to which the present bulletin especially refers. They are particularly injurious to the trees in early spring soon after the buds begin to open. Not unfrequently have I seen the small trees on tracts embracing several acres in area entirely defoliated by these flea-beetles.



FIG. 79.—The Five-lined Flea-beetle, slightly enlarged.  
[Original.]

The egg-laying habits of these flea-beetles varies but little from those of the species already mentioned that are representatives of the same family. Their larvæ are more elongate and "worm-like" than those of the Potato-beetle and the Willow beetle figured at Fig. 77.

These larvæ also feed upon the foliage—sometimes in very large numbers, and at such times also strip the trees of their leaves.

The two beetles here referred to are of a bright ochre-yellow color, marked above with black lines as shown in the figures. When disturbed they very quickly drop to the ground, where they feign death, or else they take to flight. Especially is the latter true of them on bright warm days. Although present throughout the summer in moderate numbers, they seldom gather in injurious numbers later than the beginning of June.

#### ENEMIES AND REMEDIES.

The eggs of the Willow Flea-beetles are destroyed by lady-birds, while many of the larvæ are devoured by different ones of the ground beetles (Carabidæ). Many of the beetles also fall prey to these cannibals among insects. Although related to, and having some of the offensive qualities of the different species of *Lina*, *Chrysomela*, etc., they are oftener captured and eaten by birds than are those forms. Still, comparatively few of them fall prey to birds. Generally their natural enemies keep both of these flea-beetles under control. How-



ever, when artificial remedies become necessary, the arsenical sprays (London purple or Paris green) will be found the most prompt and effectual remedies. In cases where poisons cannot be obtained, or if used will endanger the life of stock that runs loose, the beetles can be driven away by continued passing to and fro among the small trees. Large trees seldom suffer from the attacks of these flea-beetles.

## THE GRAY BLISTER-BEETLE.

(*Epicauta cinerea* Forst.)

Every year, here in Nebraska and the adjoining states, we are troubled to a greater or lesser extent by the insect that is commonly known as the Gray Blister-beetle (*Epicauta cinerea*). It congregates in large numbers upon many of the leguminous plants, but more especially upon the Horn-bean, Honey-locust and Black-locust trees, which latter are quite frequently completely defoliated by its attacks. When these trees are small, as they must necessarily be in starting groves of them upon tree-claims, the repeated defoliations by this beetle are, to say the least, very discouraging, and often result fatally to the trees.

This beetle varies considerably in size, being on an average about one-half an inch in length, and is of a uniform dull brownish gray color. In form it is elongate sub-cylindrical, enlarging very gently posteriorly; and in texture rather fragile or soft when compared with most other beetles, while its limbs are long and slender.

These blister-beetles are among our most interesting forms of insect life, both as regards their life-histories and their economic importance; and it is quite difficult for us to decide whether their existence is really more of a benefit than a detriment to us, or *vice versa*. They appear during the months of June and July, and are both diurnal and nocturnal in their habits. Professor C. V. Riley, who has been our most energetic American entomologist in working out the life-histories of insects of economic importance, published an account of the life-histories of the present and two other species of the same genus on pages 297 to 302 of the First Report of the United States Entomological Commission. In that work he shows how the eggs are laid, hatch, and the young larvæ, which at first are very active, search

for locust or grasshopper eggs upon which they feed. The life-history of these little triungulins, as they are called, is an interesting one—as portrayed by that author, but not more so than are the succeeding stages through which the same insect must pass before it can issue into the world as a full-grown blister beetle. Were it not for the lack of space, I would quote the author's paper entire. Those who would like to read the account for information can do so by referring to the above named report. In writing a report upon some work that I did for the United States Entomological Commission during the summers of 1880–1 in the Northwest the following language was used:\*

“Until quite recently the larval habits of our various blister beetles were but little understood. Since the researches of the Commission, however, the preparatory stages of many insects which had hitherto been shrouded in mystery have been ascertained for the first time. Among these were those of quite a number of the *Meloidæ*. It has been ascertained that they feed upon the eggs of locusts, and especially those of *C. spretus* (the Migratory Locust). This, then, accounts for the great numbers of these insects that are found in all the leading locust areas of the West and Northwest, especially in the latter district. Riley has shown in the report for 1878 and 1879† the peculiar and interesting feature possessed by the young of some of these insects of protracting development one, two, or even more, years, thereby supplying a new means for the continuation of a species that is dependent upon uncertainties for its continuation among the living.

“I have noticed a great number of species of these insects both in Montana and Colorado. In Montana they were mostly partial to the *Leguminosæ*—*Lupinus*, *Astragalus*, etc.—some of which, in certain localities were covered with these beetles, and denuded of their foliage, thus furnishing an example of an insect that in its preparatory stages is parasitic on another, and that after maturing lives upon a plant not eaten by the insect on which it was a parasite. In this way, then, the parasitic beetle is not only insured of perpetuating its kind through its capability of lying dormant in its imperfect stages for an indefinite time if the necessary amount of food is absent, but also through its choice of food, in its perfect state, since it lives upon that which the locust discards.”

\* Report United States Entomological Commission, Vol. III, p. 41. [1883.]

† Report United States Entomological Commission, Vol. II, p. 260; also American Entomologist, Vol. III, p. 196.

## REMEDIES.

After having learned how really useful these blister beetles can be in the destruction of locust or grasshopper eggs, it is a question in my mind whether or not it would be advisable to destroy the beetles even though they do gather upon our trees in numbers sufficiently great to injure them. If we have just had a grasshopper year, or there is a probability of our having one, my advice would be to spare the beetles at least until the majority of them had mated and deposited their eggs.

Birds or domestic fowls do not relish them; nor is it a safe plan for persons with soft hands to gather and crush the beetles between their fingers, for, like the "Spanish Fly," this beetle is also a "blister" maker when handled. If it becomes absolutely essential that something be done to save our trees from these beetles, and they cannot be driven away by repeatedly beating them off, they can be readily collected in receptacles containing kerosene or hot water. Spraying the trees with either London purple or Paris green will also kill them.

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"MAY BEETLES."

(*Lachnosterna*.)

The common May-beetles, *Lachnosterna fusca*, and allies are among the most troublesome of all insect pests with which the tree-grower has to deal. Here in the West these large and voracious insects are equally as numerous upon the prairies as they are in the vicinity of timber. In fact, they appear to be even more plentiful about new farms than old ones, because the tree-growth on these newly cultivated grounds is so scant that a moderate number of the beetles will very quickly entirely strip off the leaves, while they would make but little show if working on the foliage of trees of moderate or large size. All of these May-beetles are nocturnal in their habits and feed while we are asleep; and during daytime lie hidden away in the ground, where they burrow during early morning, only to come forth again the following evening to continue their destruction among our fruit, shade, and forest trees.

One of these beetles (*Lachnosterna fusca* is represented in Fig. 80,

where the pupa, mature larva or grub, and the imago are all shown natural size.

These different species of May and June beetles are usually about the size of the one shown in the accompanying figure, though some are larger and others smaller. They are mahogany-brown or yellowish-brown in color, and either smooth or slightly roughened; and some of them have a covering of short hairs, among which are several longitudinal rows of longer ones upon the elytra, while a few are more or less pruinose — *i. e.*, covered with a bluish-white powdery-like substance similar to that covering ripe or nearly ripe plums.

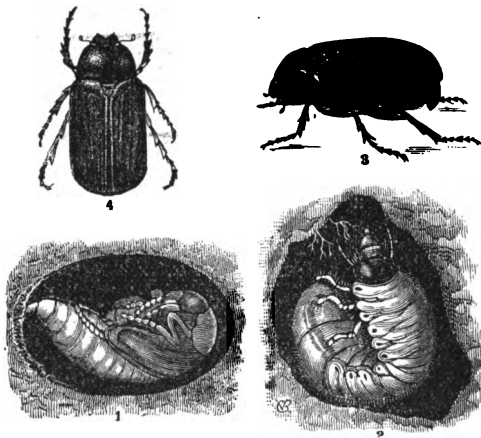


FIG. 80.—The Common May-beetle (*Lachnosterna fusca*): 1, the pupa; 2, the larva or White grub in its ground cell; 3 and 4, the beetle, side and dorsal views. [After Riley.]

So common and destructive are these insects (*fusca* and allied forms) throughout the country that, next to the Colorado Potato-beetle, Chinch-bug, Codling-moth, Rocky mountain Locust, and a few others of our most injurious insects, they have received more attention than most of our insect pests. Notwithstanding this great amount of attention paid them, we know very little that is absolutely positive in its nature about the life-history of any particular species. The species that has usually gone by the name *fusca*, but which recently has been shown to contain at least four well-marked forms, has been treated by each of our more important economic entomologists; and much that is both of interest and value has been published. Harris, Fitch, Walsh, Glover, Riley, Lintner, and others have treated it in their writings. It has also received much attention from non-

entomological writers in the agricultural and horticultural papers of the country.

Saunders, in his "Insects Injurious to Fruits," writes of these insects as follows: "Every one must be familiar with the May-beetle—or May-bug, as it is commonly called—a buzzing beetle, with a slow but wild and erratic flight which comes thumping against windows of lighted rooms in the evenings in May and early June, and, where the windows are open, dashes in without a moment's consideration, bumping against walls, ceiling, and articles of furniture, occasionally dropping to the floor, then suddenly rising again. It sometimes lands uninvited on one's face or neck, or, worse still on one's head, where its sharp claws become entangled in the hair in a most unpleasant manner."

#### LIFE-HISTORY.

The life-history of this beetle has been given in the following summary by Professor Riley (First Report Insects of Missouri, p. 157): "Soon after pairing, the female beetle creeps into the earth, especially wherever the soil is loose and rough, and after depositing her eggs, to the number of forty or fifty, dies. These hatch in the course of a month, and, the grubs, growing slowly, do not attain full size until the early spring of the third year, when they construct an ovoid chamber, lined with a gelatinous fluid, change into the pupa [See Fig. 80, 1], and soon after into beetles. These last are at first white, and all the parts soft, as in the pupa, and they frequently remain in the earth for weeks at a time, until thoroughly hardened, and then on some favorable night in May they rise in swarms and fill the air. It is very probable that under favorable conditions some of the grubs become pupæ, and even beetles, the fall subsequent to their second spring; but growing torpid on approach of winter, remain in this state in the earth, and do not quit it any sooner than those transformed in the spring. On this hypothesis, their being occasionally turned up in the fresh beetle state at fall plowing becomes intelligible."

From this summary then we are led to believe that the grub or larval state lasts from two and one-third to two and three-fourths years—a long time when we take into consideration the comparatively short life of the beetle. The actual life of the beetle after it has once left the ground is but a few days—not more than two weeks, and oftener less.

## REMEDIES.

On account of their underground life the larvæ or grubs of the May-beetles are very difficult to reach and destroy. They are not without their natural enemies, both vertebrate and invertebrate

and by far the greater majority of them are thus destroyed

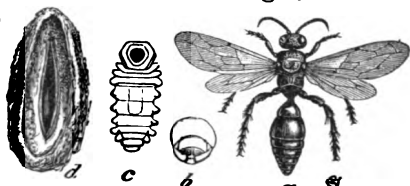


FIG. 81.—White Grub Parasite: a, imago; b, head of larva; c, larva; d, cocoon. [After Riley.]

between the time of hatching from the eggs and issuing as beetles. A large number of our birds are especially fond of the fat grubs, and can be seen industriously following the plow as it turns them up with the fresh loose soil. All kinds of domestic fowls eat them greedily, while hogs industriously search for them by rooting over the ground where they occur in abundance. Mice, shrews, moles, ground squirrels, and skunks are also remarkably fond of both the grubs and beetles. Among their insect enemies the wasp known as *Tiphia inornata* Say, is the greatest. This insect is shown in its several stages at Fig. 81. The larva of this black or bluish-black wasp attacks and destroys the grubs, after which it spins a pale brown elongate silken cocoon of the kind so frequently dug up when working the ground, and transforms to the pupa state, and later to the perfect fly. Last spring here in the city of Lincoln these May-beetles were attracted to the electric lights by the thousands, and also two large black ground beetles, *Calosoma externum* and *C. lugubre*, in moderate numbers. These latter beetles would pounce upon a May-beetle as it lay floundering upon the walk under the lights, as a cat would upon a mouse, and very quickly kill and partly devour it.



FIG. 82.—White Grub Fungus. [After Riley.]

The grubs are also frequently attacked and destroyed by a peculiar whitish fungus. This fungus

issues near the head of the grubs and occasionally attains the length of three or four inches, when it has near the appearance of the accompanying illustration (Fig. 82).

For a more accurate account of this insect-attacking fungus the reader's attention is called to the following note prepared by Mr. H. J. Webber, of the Botanical Laboratory:

"Fig. 82, representing the White Grub Fungus, the so-called *Cordyceps ravineli* Berk. & Curt., is evidently taken from an immature specimen before the formation of the head bearing the perithecia. The fungus does not usually attain so great a length, being generally only about 5 c. m. in height. It was for some time thought to be *Claviceps militaris* (L.) Link. Mr. Gerard, to whom specimens were submitted by Prof. Riley, pronounced it much nearer to *Cordyceps cinerea* (Tul.) Sacc. (The old *Torrubia cinerea* Tul.) It has since been referred to *Cordyceps ravineli* Berk. & Curt., to which it likely belongs. The figure, however, appears somewhat at fault if of this species. The stem is rather slender and too long—approaching in these respects the *Cordyceps acicularis* of Ravinel.

"I have specimens of a fungus in the same stage from West Point, Nebraska, collected by Mr. Bruner, that seem to be *Cordyceps acicularis* Rav. They grow singly from the head of larvæ of the beetle family Tenebrionidæ (probably of the genus *Nyctobates*). They are fully 8 c. m. in length, and only about 1 mm. in width, having much the appearance of Prof. Riley's figure, being in the same stage, i. e. before the formation of the head bearing the perithecia.

"A full discussion of this white grub fungus by Prof. Riley may be found in the *American Entomologist*, Vol. 3 (1880), p. 137."—H. J. WEBBER.

Many of the beetles can be destroyed by jarring the trees over sheets and gathering them as they fall, after which they can be drowned in boiling water or thrown into the fire and burnt. Other methods can be devised by those who have the insects to fight,—circumstances, of course, directing these forays against the enemy.

## APPENDIX.

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The foregoing pages are devoted to such of the tree-claim insects as are injurious to the trees by devouring the foliage, and hence they have been termed "Tree-claim *Defoliators*." There are a few other insects that are equally injurious to tree culture in the region embraced in the report that do their damage in other ways. It has been thought best to mention the most important of these also, but to treat of them in an appendix to the main report. I have also added a short paper on "Insecticides, and How to Apply Them," thinking that such a paper would be appreciated by the public in connection with the other contents of the bulletin.

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### TREE CRICKETS.

Few if any of our injurious insects are more widely and generally distributed over the state, and for that matter over North America, than the common Snowy Tree-cricket (*Eucanthus niveus*) which is herewith figured. Figure 83 represents the female and Fig. 84 the male, both natural size. This cricket, as the name implies, is whitish or greenish-white. It is a very common insect, and can readily be recognized by the accompanying illustrations; therefore a description of it is unnecessary here.

While this particular cricket is less injurious to young trees than many other indigenous noxious insects, its peculiar mode of attack brings it into notice much more frequently than they. By reference to the accompanying figure (Fig. 85) which is intended to represent a raspberry cane that has been injured by this cricket, its mode of attack can be seen. Instead of destroying the plant by devouring the foliage or twigs, as is usually the case with insect depredators, this species unintentionally becomes an enemy by using the stems of various pithy plants as receptacles for its eggs during the winter—the result being alike favorable for the parent and progeny whether the twigs or stems die or live.



Chief among the cultivated plants thus worked upon by this insect are the raspberry and blackberry. So partial is it to these plants as receptacles for its eggs, that in some localities, where not combated, scarcely a vine escapes without receiving one or more batches of the eggs. Where the stem or twig is small and the eggs numerous, the portion beyond the point injured dies; but if large and the eggs few the damage to the part is only temporary, and the plant recovers. In addition to the above-named plants, the Snowy Tree-cricket also deposits its eggs in the stems of a large variety of other plants and trees—



FIG. 83.—Snowy Tree-cricket (*Ecanthus niv-eus*); female. [After Harris.]

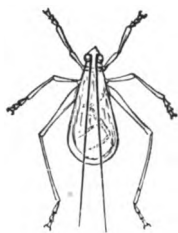


FIG. 84.—Snowy Tree-cricket (*Ecanthus niv-eus*); male. [After Harris.]

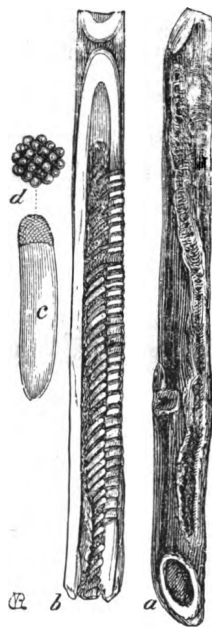


FIG. 85.—Snowy Tree-cricket: a, raspberry cane showing egg punctures; b, transverse section; c and d, magnified view of egg. [After Riley.]

the main requirements being a soft fibre and pithy interior to the twigs selected. Among the trees the white willow suffers most. I have seen hedges of this tree so completely utilized that scarcely a twig escaped being deposited into. Other species of willow, cottonwood, elm, maple, box-elder, cherry, dog-wood, black locust, sycamore, ash, honey-locust, and in fact almost all kinds of trees, are sometimes attacked. Elder is a great favorite, too. After these come weeds, as the artichoke,

sunflower, golden-rod, ambrosia, and many others. All of these latter being annuals, or dying to the ground each year, whether attacked by the cricket or not, the conclusion is plain. All the cricket requires is a receptacle for her eggs. It matters but little whether a dead or living plant furnishes that condition.

In the case of the honey locust, the thorns as a rule receive the eggs instead of the twigs, and no apparent damage is done. The mature crickets are also to be met with abundantly upon the oaks, hickories, and elms during the egg laying season, and evidently use these also occasionally for the deposition of their eggs, although I have never obtained or noticed the eggs in the twigs of these trees.

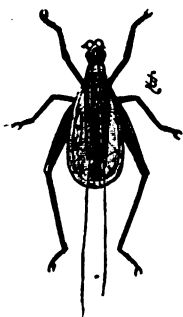


FIG. 86. — Broad-winged Tree-cricket (*Ecanthus latipennis* Riley); female. [Original.]

While woody plants are known to be very commonly used as receptacles for the eggs of this cricket, it is by far more numerous upon such weeds as those mentioned above during its entire career; but more particularly so during its latter days when looking after the perpetuation of its kind.

The *Ecanthus niveus* has two close allies here in Nebraska that are almost equally common in some parts. These likewise are guilty of similar egg laying habits; but as they are not so general in their choice of egg-laying receptacles, their injuries are less prominent. They are also somewhat choice in the haunts which they frequent, which characteristic partially excludes them from receiving blame for injuries which might otherwise be charged to their account. These are the Wide-winged Tree-cricket (*Ecanthus latipennis* Riley), and the Black-horned Tree-cricket (*Æ. nigricornis* Walk). The former of these is somewhat larger than the common snowy species, and the male has the anterior wings very broad and somewhat clouded along the heavy diagonal veins of the disk. It is figured herewith at Fig. 86. The female is like that of *Æ. niveus*, only larger and correspondingly more robust. The other species has black antennæ or feelers, and feet, as well as being generally darker than either of the two others mentioned. It is of the same size as the snowy one. The *latipennis* is a frequenter of woods and thickets, especially where grape-vines occur, and is the one which should receive the blame for much of the "tree-cricket" injury to our vineyards. The *nigricornis*, on the

other hand, is a meadow frequenter, and sports among weeds and grasses. It deposits in weeds as a rule, and should not be too greatly scored for the injuries perpetrated by the other two.

Two other species of tree-cricket occur in the region covered by this bulletin, although in rather fewer numbers than do the others. These are the *Ecanthus fasciatus* Fitch and *Æ. angustipennis* Fitch. Both of these crickets have similar habits with those of the species just described. The first of these can be recognized by its much longer antennæ than the others have, "being more than two and one-half times the length of the insect." It also has the long spines at the tips of the posterior tibiæ very large, strong and acute. The *angustipennis*, as the name implies, can be distinguished by its very narrow elytra in the male, and in its small head and narrow pronotum. Its hind legs are also longer and slenderer than in the other species. Both of these last named insects are more or less greenish in color, and appear to have the wing covers more leathery in texture than they are in *nevius* and *latipennis*. They are most abundant in groves.

If these tree-crickets do cause great havoc among the plants which we cultivate for profit and pleasure, for use or beauty, it is only that they too aim to remain among the living of this world. True they must feed upon these plants to some extent, but what little they devour is never missed; and were it not for their coming across our pathway as enemies to the plants which we prize, we would willingly overlook their attacks upon vegetation.

The Snowy Tree-cricket, and perhaps also all of the other species mentioned above, are known to feed largely upon plant-lice of different kinds that infest the vegetation frequented by these crickets while among the living in the insect world. So decided is this cannibalistic habit with them, that, taking everything into consideration, I doubt not but the benefit resulting from their presence exceeds the injury done by them. The carnivorous habit is quite general among the various representatives of the cricket family; but up to the present time it is not generally known among entomologists that these tree-crickets of the genus *Ecanthus* at least are such confirmed destroyers of plant-lice and other small, soft-bodied insects.

Professor Riley speaks of this habit in one or two places, while Miss Mary Murtfeldt has just written an article for *Insect Life* in

which she dwells upon this food habit of the Snowy and Broad-winged species.\*

CANNIBALISTIC HABITS OF.

Since writing the above I have had an opportunity to examine into this feature of the subject a little more. I have also read Miss Murtfeldt's paper referred to above. It is so interesting and to the point that I quote portions of it here for those who may not have the opportunity to read it elsewhere.

"From observations and experiments on the Snowy Tree-crickets (*Ecanthus niveus* De Geer and *Æ. latipennis* Riley) during the past two summers, I incline strongly to the opinion that they should be classed with the beneficial rather than with the injurious species. \* \* \* During the present season I colonized a considerable number—mostly *Æ. latipennis*—on a portion of a grape-vine and watched them at all hours of the day, without ever detecting them in the nefarious work of snipping off either berries or bunches. Nor was there any circumstantial evidence of their having done anything of the kind at night. Furthermore, all my observations upon them in the rearing cage prove that at no stage of their existence can they subsist on vegetable food, either fruit or foliage. When deprived of other insects for their sustenance, they invariably perished.

"Early in June of last year I had a colony of *Æ. niveus* hatch from apple twigs that had also been badly punctured by *Cerasa bubalus* [the Buffalo Tree-hopper]. At hatching, each tiny cricket left at the aperture of the bark through which it emerged the filmy pellicle in which it had been enclosed in the egg. There were about a dozen in all, and I kept them under constant observation on my writing desk. During the day they remained almost motionless in one position, if possible concealed from light and sight, on the under side or in the folds of a leaf. They were, from the start, supplied with various berries, and tender leaves, but evidently never touched them for food. On the morning of the fourth day two or three were dead, and showed signs of having been nibbled by their hungry brothers. Some leaves of plum infested with a delicate species of yellow aphid were then put into the jar, but attracted no immediate attention. As twilight deepened, however, the crickets awakened to greater activity. By

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\**Insect Life*, Vol. II, No. 5, pp. 131-3. November, 1889.

holding the jar against the light of the window, or bringing it suddenly into the lamp-light, the little nocturnal hunters might be seen hurrying, with a furtive, darting movement, over the leaves and stems, the head bent down, the antennæ stretched forward, and every sense apparently on the alert. Then the aphides provided for their food would be caught up one after another with eagerness and devoured with violent action of the mouthparts, the antennæ meanwhile playing up and down in evident expression of satisfaction. Unless I had provided very liberally not an aphid would be found in the jar the next morning, and the sluggish crickets would have every appearance of plethora. Later on in their lives, by reducing them to the point of starvation, I repeatedly made them feed in the daytime, so that I might the more readily observe the process, which certainly is very interesting. \* \* \* \* \*

"During the present summer my attention was again attracted to these insects by finding them so constantly and numerously on oaks infested with *Phylloxera rileyi*. Every leaf dotted by the aphid would have its tree cricket, in addition to various smaller foes. The species most commonly seen was *Æ. latipennis*, distinguished to casual observation by its somewhat larger size and by the brilliant orange red or red and yellow dorsal stripe of the pupæ. The size and the broader wings sufficiently characterize the mature insect. A close examination reveals many less obvious distinctions between the two.

"I found that one specimen of *Ecanthus* would clear the *Phylloxera* from a large oak leaf in the course of a single night when confined to a single leaf. On one occasion one of the crickets ate two saw-flies which had emerged in the jar; I am not positive that it killed them, but it certainly devoured all the softer parts of the body. I have also had them feed upon various kinds of small leaf-hoppers and tingids, and am convinced that they are thoroughly and constantly carnivorous, and therefore a valuable ally in reducing the numbers of our smaller insects."

Aside from their injurious qualities these tree-crickets are rather attractive little creatures. Their song is a low, sweet, continued trill, very similar to the spring-time song of the toad, and not harsh and shrill like that of some of the ground-inhabiting species. It is the low mournful chirrup that tells so plainly of the approach of frost, fall, and cold weather—the funeral dirge of summer, as well as the note of

courtship. The various species of *Eoanthus* belonging to the insect fauna of the United States differ one from the other in song only in the pitch and length of intervals between the notes produced. They all trill. There is a species of this genus, however, found in Central Mexico, which is new to science, whose song, while still a trill, is interrupted, and reminds one of the croak of a tree-toad or small frog, rather than the song of an insect. The music of crickets, katydids, and other orthopterous insects is produced by stridulation, or scraping. Their wings, which are furnished with strong veins united by very thin, parchment-like cells, are the organs of song. They are fiddlers, not singers. With these crickets the males alone are gifted with the power of "song;" as they are, in fact, among all other musicians of the insect world. Insects are players, and not vocalists.

The family of insects to which these tree-crickets, along with a large number of other forms belong, is known to entomologists by the name *Gryllidæ*.

All of these insects have received the popular name of crickets; as for example the mole cricket, house cricket, field cricket, timber cricket, etc. The family is a very extensive one, and is made up of a large number of widely different forms. These also differ greatly among themselves in habits and mode of life. In their distribution over the earth they include every climate where the seasons of sunshine and warmth are sufficiently long for their development. The warmer portions of the temperate zones and the tropical countries are, however, their true home. As a whole the group is composed of species that are injurious. Like the katydids and cockroaches, also representatives of the same great group, or order of insect life, with the crickets (*Orthoptera*), these latter are nocturnal, or essentially so, in their nature. Some crickets, like the above named, are arboreal; that is, they live above ground upon plants, while others are ground dwellers. Still others live within the nests of ants.

#### REMEDIES.

After devoting so much space to the life-history and habits of these insects, it would be wrong not to mention a remedy by which their injuries can be prevented, if it is desirable to do so after ascertaining what great benefit they also are to the horticulturist, by aiding in keeping under control smaller insects such as plant-lice and leaf-hop-

pers. Birds, and a few of the insectivora among mammals, devour these crickets eagerly, as do also quite a number of the predaceous beetles and wasps. The *Asilus* flies among the *Diptera* also destroy a few of them. They also suffer from parasites\* and disease, as do all other insects. In addition to these natural checks, we can do much toward their diminution by gathering and burning the injured twigs, and other harbors containing their eggs. This should be done in winter or spring, before the eggs hatch.

## THE BOX-ELDER BUG.

(*Leptocoris trivittatus* Say.)

Everybody in this region lying west of the Missouri river is familiar with the insect shown in its different stages of growth in Fig. 88. However familiar many of us may be with the bug, most of us undoubtedly are ignorant as to its habits, mode of life, enemies, etc. This being the truth, and the insect being directly injurious to the growth of young trees upon tree-claims, I will devote some space to its past history and habits.

The insect was first described by Thomas Say from specimens which he collected at "Engineer Cantonment," during his connection with Major Long's expedition to the Rocky mountains, in 1819-20. This locality is in Nebraska a few miles north of the present city of Omaha. Professor E. A. Popencé has written a rather full life-history of the insect in his annual report for 1888.† We quote, therefore, largely from that source.

### HABITS.

"This species has been known in this locality [Manhattan, Kas.] for over ten years as a tree pest, appearing at times in great numbers upon the box-elder, and occasionally attacking the ash. During the winter the adults are hidden in sheltered nooks and corners everywhere, but are especially abundant in crevices of stone walls and the angles of stone buildings, on the south sides of which they appear,

\*During the past summer I have bred two species of Hymenopterous parasites from twigs containing the eggs of these crickets. These parasites are both new to science — never having been described. One of them is a *Calotelea* and the other a *Rileya* (?).

† First Annual Report of the Kansas Experiment Station, 1888, pp 56-61.

singly and in clusters, every warm day during the season. As soon as the increasing warmth of spring allows, they leave these shelters and seek the trees attacked by them. From the time of their scattering in spring until the appearance of the first adults after midsummer they are less conspicuous, and are not likely to be noticed except upon search directly for them. It is at this time, however, that their eggs are laid in creases of the bark, on the trunk, and also upon the twigs of the trees attacked, as well as occasionally on the bark, twigs and leaves of other trees, and the numerous young are hatching and beginning their work on the trees. After midsummer, their gregarious tendency is manifested in the flocking of bugs of all sizes and in great numbers in lines up and down the trunks and branches. Not infrequently they may be seen crowded in a broad line extending from the ground to the secondary branches, the company including larvæ of all sizes, pupæ, and fully matured individuals. This habit persists more or less completely until October and November, or until the trees are bare. During the warm days of

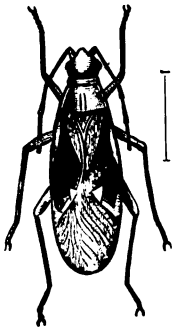


FIG. 87.—The Box-elder Bug (*Leptocoris trivittatus*). [Original.]

Indian summer the bugs fly everywhere, flocking to the warm sides of buildings, and entering houses, where, though otherwise harmless, they become troublesome through their abundance and through their propensity to fall clumsily into pails of water, crocks of milk, and other articles of food left uncovered.

"They are principally found, as stated, upon box-elder trees, but observation shows them to be much more general in their selection of food-plants. They feed also on the ash, and I have observed them in abundance sucking the sap from the *Ampelopsis* clinging to the south side of a stone building. Into the greenhouse many make their way during the autumnal flight, and such are specially fortunate; for they find there not only the desired warm shelter, but abundance of food as well. They are not slow to test the qualities of the juices of the plants growing in the house, and we have seen them with beaks inserted in the stems of geraniums, cactuses, lilies, coleus, ageratum, and other plants."

Here in Nebraska I have seen the insect frequently quite injurious



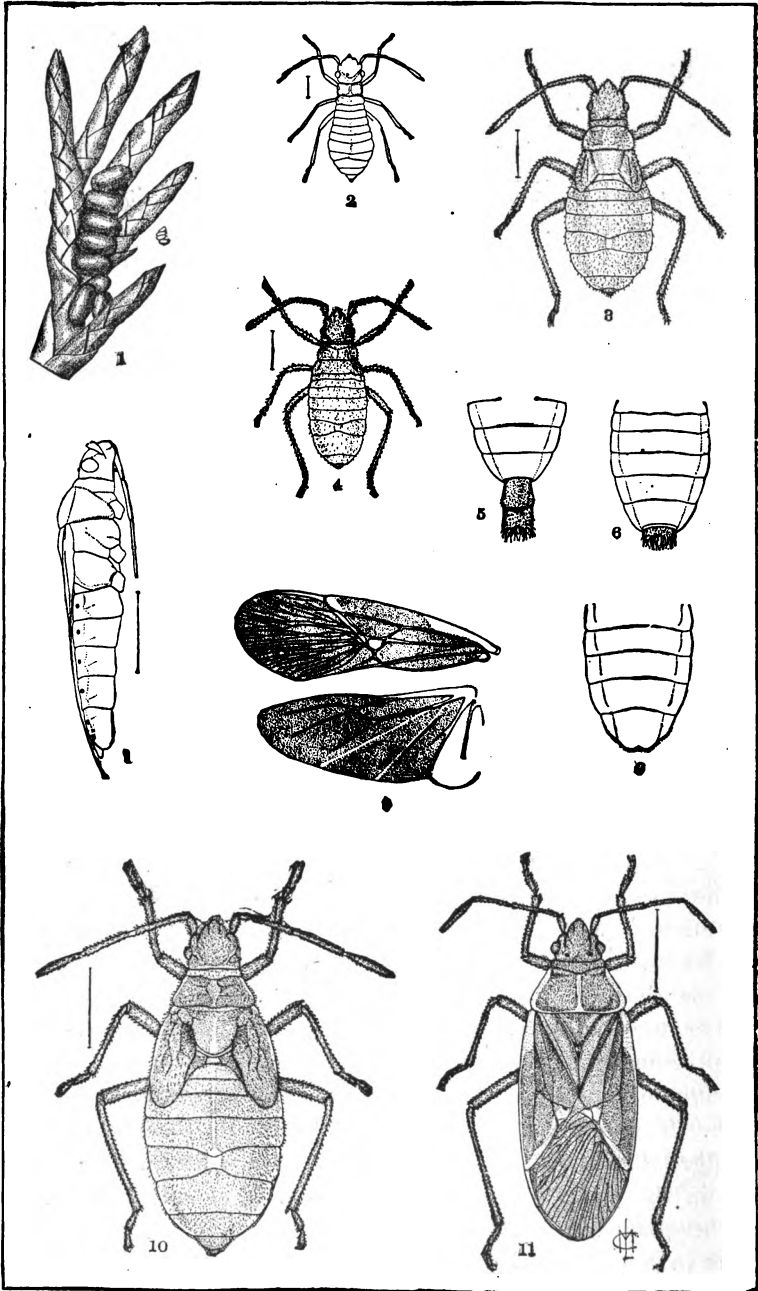


FIG. 88.

to the white or soft maple. It also occasionally injures fruit upon the trees.

#### DESCRIPTION.

The following description of the insect in its various stages has been drawn up from the examination and comparison of numerous specimens. The illustrations which accompany this, together with the description, are taken from Popenœ's report referred to above. The drawings were made by Mr. C. L. Marlatt, now of the United States Department of Agriculture :

"The color in the earlier stages of the insect is nearly uniform, varying slightly in different individuals and ages from orange scarlet to a deeper or blood red. Specimens of the youngest larvæ are of the form shown in Fig. 2, and uniform red throughout. Succeeding stages, shown in Figs. 4 and 3 in the order of growth, have the same body color, with the tip of the beak, the tarsi and the tibiæ obscured with brownish shadings. The full grown pupa (Fig 10), of the same red color, has the inner edges of the wing pads a decided brownish black, shading outwardly into the pure red of the exterior; the feet and beak more distinctly brown than in Fig. 3; a narrow, median, yellowish-white line along the back, expanding on the contracted fourth abdominal segment into an oval patch. A trace of this line is observed in the earlier stages. The adult, shown in Fig. 11, measures 10-14<sup>mm</sup> (.4-.6 inch) in length, and, when fully colored, is dull black, marked with orange scarlet. The head is dull black, with the eyes and ocelli deep blood red; the prothorax black, with a median and two lateral lines, and usually the posterior margin narrowly, red; the remaining upper parts, when the wings are folded, appear dull black, except the tip of the scutel, the exterior margin of the wing, and the oblique tip of the thicker basal portion of the wing, which are red, the red exterior margin of the wings being broad at the shoulder and abruptly narrowed to a line behind this. In some specimens, two or three prominent veins and the scutellar margin of the wing are also red. Under the wings, the dorsal surface of the abdomen is red, with two rows of black spots. Beneath, the thorax is black, the coxæ red; the abdomen red, with a broad black line on each side from base to the terminal segment, which is entirely black.

"The male is distinguished by the usually narrower abdomen (Fig.

6) and by the curiously lobed extensile tip of that part (Fig. 5), the corresponding part of the female being rounded (Fig. 9)."

#### REMEDY.

On account of its habit of gathering into great clusters, it is not difficult to wage war against this bug. When thus gathered upon the ground, on walls of buildings, or upon the trunks of trees, it can readily be destroyed by the use of kerosene or boiling water. Birds and other insectivorous animals are not very partial to it, nor to any of the members of the order to which it belongs, all of which are very "odoriferous," and presumably not especially delightful to the taste. Carnivorous insects are slow to attack and destroy it, while but few parasites infest the insect in its different stages. I have seen egg shells that had evidently been punctured by a small Chalcid fly of some kind. But I have not been able to breed this parasite. The Box-elder bug is also frequently subject to the attack of a fungoid disease — probably an *Epusa* or *Eutomophora* similar to, or identical with, the one that attacks the Chinch-bug.

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#### PLANT LICE.

Not only are there insect defoliators, but also other kinds as regards their mode of attack upon our young trees. Among the latter, plant lice are quite prominent; and upon tree-claims are often quite troublesome. The willow, cottonwood, ash, box-elder, elm, etc., are each attacked by one or more species of these soft bodied insects.

Plant lice are among the most rapid multipliers in the insect world; and living as they do, upon the sap of plants, often do much injury to the vegetation which they infest. Some of these lice, for there are many kinds or species of them, are quite general in their feeding habits, but as a rule they are partial to a single kind, or at most but a few different kinds of plants. Knowing as we do that but few plants are without their insect enemies among the plant lice, it is quite evident that there are a great many kinds of these insects. As we find different habits among allied forms of other groups of insects, so also do we find that various of the plant lice also differ among themselves in habit.

Aside from their polymorphic nature and their queer modes of reproduction, these insects offer many interesting features for study and thought, but as these are a side issue, they will be omitted from the present article.

Plant lice are all suckers, and live by extracting the juices from vegetation by means of a beak which they insert in the bark, stem or leaf, according to the part of the plant which they infest. Some of them live within galls or extraneous growths upon the plant produced by their presence. These galls are to be found both upon the roots

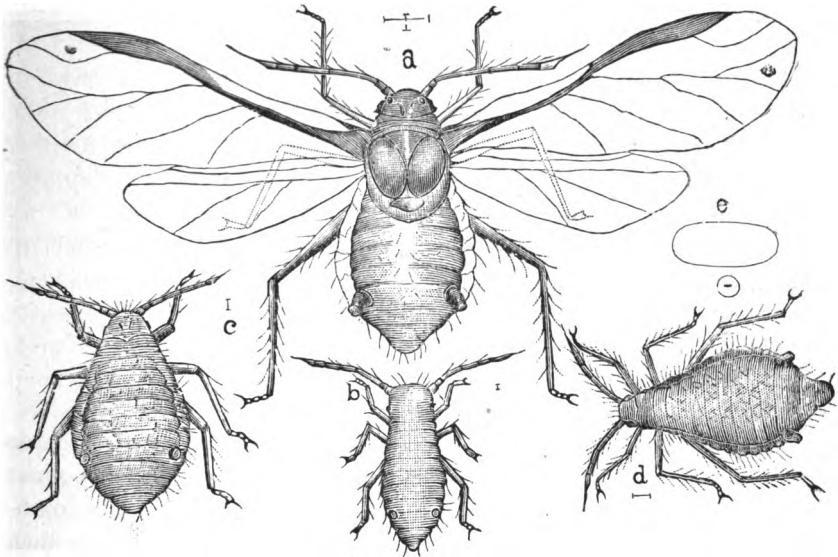


FIG. 89.—Box-elder Plant-louse, (*Chaitophorus negundinis*): a, winged viviparous female; b, young from viviparous female; c, viviparous apterous female; d, apterous oviparous or true female; e, egg—all enlarged. Male not figured. [Original.]

and above ground. Others again live free upon the leaf, stem, trunk or root—according to the species of louse and the plant infested. But the study of the life-history of these insects is the most interesting portion of an entomologist's work in connection with them. While some of them are comparatively easy to follow through their annual cycles of life from the egg, others again are a puzzle to him. Some of them live the year round on the same food-plant, and above ground, while many of them forsake the branches and foliage as cold weather approaches and enter the ground, where they feed in another form upon the roots and rootlets. Again still other species feed upon

one plant or group of plants during one season, only to forsake these for those of another at a different season of the year. In order then to know the complete life-history of any of these many species of plant lice it is necessary for the student to trace each species separately throughout the year, and in some instances through a number of years, before he can be positive as to its identity and mode of life. As an example of the modes of reproduction common to the Aphidiniidæ, or family of plant lice, I will give a short outline of that of the

### BOX-ELDER PLANT-LOUSE.

(*Chaitophorus negundinis* Thos.)

This louse, like those infesting various other trees and herbs, occurs in several forms, both winged and apterous. It is green — the color of the tender twigs and leaves upon which it attaches itself by means of its beak, which is used for extracting the juices or sap upon which it is nourished from the tree.

Early in spring, even before the tender leaves have made their appearance, the eggs that were deposited the previous fall hatch, and the little fellows gather about the opening buds, where they wait patiently, and perhaps shiveringly, too, so as to be ready to attack the first green growth that appears. These little lice that come from the eggs are of the form known as agamous females; that is females that produce young without the intervention directly of the opposite sex. These females are also viviparous, that is to say, their offspring are produced alive, which later are also of a like nature. Just when the first winged specimens of this louse are to be found we do not know, nor are we prepared to give an outline history of their special mission in the cycles of this insect's annual existence, further than, perhaps, the spreading of the species from one locality to another. Some of these winged specimens at least, like the wingless agamous form, are also viviparous. In the fall of the year, after the first frosts and when most of the leaves have fallen, the true female, which is a wingless form, lays eggs. These eggs are usually thrust in crevices of the bark, and between the buds and twigs. By means of these eggs it is carried through the winter, and the continuance of the species is insured for the following year.

As above stated this insect begins its work just as soon as, or before, the leaves appear in spring, with the viviparous agamous female, or

stem mother. She becomes full grown in a few days, and begins the process of reproduction by "budding" internally and expelling small lice of her kind, which in turn, after maturity, repeat the operation. The successive generations continue without interruption during spring and summer, some of them being furnished with wings, which enable them to migrate from place to place. In this manner new localities become infested, damp weather favoring and very dry weather retarding their excessive increase.

Like many others of the family to which it belongs, the box-elder louse is provided with a pair of "honey-tubes," or nectaries, as they are sometimes called. These are the two short tubular projections which arise from the sixth abdominal segment above, and on each side of the middle. They are connected with internal glands, which secrete a sweet or saccharine fluid, that flows continually while the insect feeds. The "honey dew" has its source here, and is nothing more nor less than the secretion of some aphid. Wherever any of the nectary bearing aphids occur in large numbers, and sometimes even in small numbers, there are many species of different insects congregated about, having been enticed thither by the "honey dew," upon which they are fond of feeding. Chief among these "camp followers" of plant lice are a number of species of ants, that live upon the fluid secreted from the "honey tubes" of the lice. So fond are these ants of this saccharine fluid that many species of them are known to stand guard over the "cows," driving away parasites and other insects where this is possible. Some of the different kinds of ants even make the lice captives, carrying them down into their nests and feed them so as to be able to milk them.

#### DESCRIPTIVE.

EGG.—The egg when first laid is light transparent greenish-yellow, but after a time becomes darker, taking on the color of the bark of the twig upon which it is laid. In form it is elongate oval, very smooth and glossy, nearly the same at both ends, and destitute of any perceptible sculpturing under ordinary low powers of the microscope. Like that of other species of the group, it is large for the insect which lays it, being about .8mm in length.

VIVIPAROUS APTEROUS FORM.—The "stem mother," or viviparous apterous form, is rather broadly oval, inclining to pyriform in outline, gradually widening from the head posteriorly to about the middle of the abdomen, from which point it tapers more abruptly to the style. The whole body is covered with small tubercles from which proceed moderately large, stiff hairs or bristles. The legs are also cov-

ered with these bristle-like hairs. The general color of this form is green, with the head brownish during the spring and summer. In the fall, after the leaves have fallen, and the lice have removed to the twigs, their color becomes darker, resembling that of the bark upon which they are found, that at this time of the year is brownish-green. The apterous females which lay the eggs differ from the agamous form in being slightly more elongate, more cylindrical, and in having the abdomen somewhat narrower. The antennal joints of the latter show plainer and the eyes are larger than there. The honey-tubes are also better developed in the true female than they are in the viviparous form. Her color is also perceptibly darker green or brownish green than in the form described above.

**WINGED FORM.**—The winged individuals are very similar in form to that of the apterous female, being of an oblong oval outline. In size it is a little larger than they, being fully 2<sup>mm</sup> in length. The wings are very delicate in their structure, and when folded reach considerably beyond the tip of the abdomen; when spread they have an expanse of about 6<sup>mm</sup>. Like the apterous forms these winged individuals are also covered with bristle-like hairs. General color green, with the thorax varying from brown to black.

#### REMEDIES.

Happily for us, these lice have their natural enemies that usually keep their numbers within bounds. Were it not so, with favoring atmospheric conditions, their rapid mode of increase would very soon permit of their completely covering the trees, trunk, limbs, twigs, and leaves. Should such be the case the result to trees is evident. Among the enemies of these aphids are the lady-birds, with their bright-col-

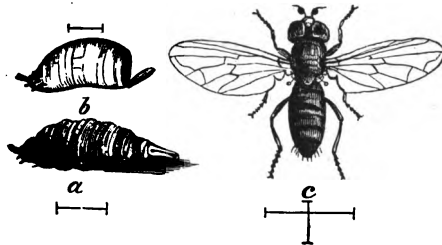


FIG. 90.—The Root-lice Syrphus-fly (*Pipiza radicum*): a, larva or maggot; b, puparia; c, fly. [After Riley.]

ored dresses, dotted with black, like calico gowns. Several kinds of these beetles (Figs. 90 to 96) occupy themselves, both in the mature and larval stages, by feeding upon the lice. The lace-wings (Fig. 96) which are allies of the dragon flies, also live almost exclusively upon them. In addition to these a large number of sunflies (Syrhids) also live upon the lice in their larval or maggoty form (Fig. 90). These insects are all predaceous in their nature, devouring the lice

bodily as a cat does a mouse.\* Aside from these predaceous enemies, there are certain others that destroy their prey in another way. These latter are very minute, four-winged insects, belonging in the same order with the bees, wasps, and ants, viz., the Hymenoptera. These little chalcids, for such is the name given to the group, are parasites in the true sense of the word. They sting their host, drop in an egg and are away. This egg hatches and discloses a grub that bores into and lives upon the vitals of the victim, which latter dies when the uninvited guest has attained its growth and is ready to issue forth into the world of contest on its own behalf. Of course these chalcids are small—

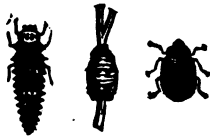


FIG. 91.—*Hippodamia convergens*. [After Riley.]



FIG. 92.—Larva of Ladybird. [After Riley.]



FIG. 93.—*Hippodamia 13-punctata*. [After Riley.]



FIG. 94.—*Coccinella 9-notata*. [After Riley.]



FIG. 95.—*Hippodamia maculata*. [After Riley.]

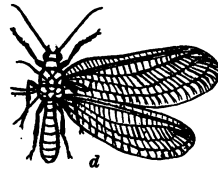


FIG. 96.—Lace-wing: a, eggs on leaf; b, larva; c, d, mature insect. [After Riley.]

much smaller than the lice within the bodies of which they feed and mature.

Sometimes, notwithstanding all these natural enemies and parasites do towards keeping these insects in check, favoring circumstances arise that permit of their increasing in numbers sufficiently to materially injure the plants upon which they feed. When such is the case, other and artificial means of warfare must be resorted to in order to prevent their injury to vegetation.

\* See also under head of carnivorous habits of Tree-crickets, pp. 123-5, of this bulletin.



The remedy usually employed for this pest is the application of some preparation of alkali or kerosene. Strong soapsuds sprayed on the parts affected with a force pump will usually kill the lice; but if not, then a sure remedy is found in an emulsion of kerosene, to be applied in like manner. This emulsion is described under the heading of Insecticides in the succeeding article of this bulletin.

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## INSECTICIDES.

In conclusion, I present herewith a short paper on the different insecticides that have been found by a long series of experiments to be most effective in the destruction of the various insects with which the tree grower must deal.

After having carefully studied the life-histories and habits of the different insects that attack our trees externally, we find that they all belong to either the one or the other of two classes as regards their mode of attack; *i. e.*, they either take their food solidly or else in the fluid form. The former devour the foliage, and the latter suck the sap from the leaves and bark of the smaller limbs and twigs. Therefore, in the choice of our remedies, we must take these habits into consideration. Those that devour the foliage can be killed by poisons taken into the digestive canal with the food, while such as live upon the juices of the plant only must be reached and destroyed otherwise.

Of the so-called "insecticides" and "insectifuges" there are a great many; some of which, of course, like a certain per cent of all other patent nostrums, are worthless, and should not be bought or used. There are a few of them, however, that are "genuine" and can be depended upon as being just what is claimed for them. Among these latter we can rely upon Paris green, London purple, kerosene emulsion, Persian insect powder, bisulphide of carbon, and a few of the alkali washes. None of these are protected by patents, nor do they contain constituents that are unknown to the user. Besides, their comparative cheapness must go far towards recommending them for general use.

Of course, in using most of these insecticides, it is necessary to proceed with caution, for otherwise danger may result both to the operator and to stock, as well as to the tree or plant upon which they are applied.

## HOW APPLIED.

The method of applying these insecticides has much to do with their efficacy upon the insects which are intended to be destroyed. It is therefore quite as necessary for us to choose the best methods of applying the poisons, as it is to secure the best and most sure insecticides. A loose, careless application of the very best material will often be an entire failure; whereas, if properly applied with a good force pump in the form of a fine spray the work will be all that could be desired.

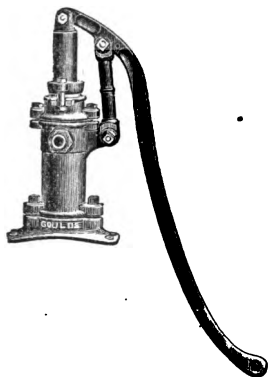


FIG. 97.—Force-pump made for applying insecticides to trees, etc.



FIG. 98.—Showing use of force-pump for spraying insecticides from wagon.

A very good pump for this purpose is shown in Fig. 97. It is manufactured by the Goulds Manufacturing Company, of Seneca Falls, N. Y. Of course any other good pump will answer the purpose. Fig. 98 shows the use of this pump from a wagon. It will work equally well with double or single discharge pipe, or for the application of arsenical or kerosene preparations.

## THE ARSENITES.

Under the name of arsenites we have two very effective insecticides. These are the London purple and Paris green of commerce. The first is an arsenite of copper, and the second an arsenite of lime. They are both preferable to the white arsenic itself for use as insecticides on account of their color, which acts as a sort of safeguard against accidents, and also from the fact that they are more readily held in suspension. The London purple, made by Hemingway's London Purple Co., of London, England, is much cheaper than the Paris

green, and is just as effective in its work on the many insects for which the latter has been recommended and used. Professor A. J. Cook, in a recent bulletin, writes as follows about these two insecticides:\*

"As London purple is much cheaper than Paris green, costing only fifteen cents per pound, and is just as effective in practical use, it should always be used when it can be had, unless on very tender foliage, like that of the peach, when only Paris green should be made use of. It is still a question if the arsenites should be used on the peach.

"London purple may be used either dry, mixed with land plaster—one pound of the poison to eighty or one hundred pounds of the plaster—or mixed with water—one pound to two hundred gallons of water.

"It is not the strength of the mixture, but the force and thoroughness with which it is applied, that secures success. The water mixture, which will usually be most satisfactory, should be kept well stirred, that the heavy mineral poison may not settle." He goes on and states further that London purple "*SHOULD NEVER be applied to fruit trees TILL THE BLOSSOMS FALL FROM THE TREES;*" and that it "should be applied to apple trees but once, except in case of very heavy rains, when it should be repeated two or three weeks after the first application; should be used two or three times at intervals of ten days or two weeks on the plums, and after every heavy rain; may be used to defend against the potato beetle and all leaf or bud-eating insects that defoliate our fruit trees early in the season, and on our *SHADE and FOREST TREES* for such insects at any time." \* \* \*

#### KEROSENE EMULSION.

So far as I know, next to London purple and Paris green, no other preparation equals kerosene as an insecticide. In fact, personally, I prefer the use of the kerosene to the arsenites; for, like the darkies in the cotton fields of the south, I am afraid of "pisen" under all circumstances. The *pure* kerosene is, however, just as injurious to vegetation as it is to insect life. To dilute it with water is not possible without the addition of soap or fresh milk. Either of these latter, if thoroughly mixed with a certain proportion of the oil, will render it possible to be diluted with water to such a degree that it will no longer destroy the foliage to which it is applied.

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\* Bulletin No. 58 of the Michigan Agricultural College Experiment Station.

The term "kerosene emulsion" probably had its origin in the Department of Agriculture at Washington, although Professor A. J. Cook possibly was the first to use the mixture as an insecticide. He (Cook) writes about this insecticide as follows in the bulletin already quoted:

"The great value of this substance rests in the fact that it kills by contact, and insects that suck, like lice and true bugs, are killed by its use. \* \* \* The way I prepare this kerosene and soap emulsion is as follows: I mix one quart of soft soap, or one-fourth pound of hard soap, with one or two quarts of boiling water; as soon as the soap is all dissolved, I stir in, while all is yet hot, one pint of kerosene oil. This is now violently stirred till it is permanently mixed—that is, till, upon standing, the oil will not rise to the top, but will remain incorporated with the liquid. This stirring is best done by use of a force pump—pumping back into the vessel containing the liquid. When we are ready to use this, stir in enough water to make fifteen pints in all—that is, one-fifteenth of the liquid applied would be kerosene oil."

The following formula has been used by the members of the Division of Entomology in the United States Department of Agriculture for making this emulsion, and has been found to give the best general results. It is generally known as Hubbard's formula, because first used by that gentleman in his experiments with orange insects:

"Kerosene (the common lamp oil).....	2 gallons.
"Water.....	1 gallon.
"Common washing soap.....	$\frac{1}{2}$ pound.

"Heat the solution of soap, and add it boiling hot to the kerosene. Churn or agitate the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives three gallons of emulsion, and makes, when diluted, thirty gallons of wash."\*

Either of these formulæ will give a wash of sufficient strength, if properly applied, to kill both the insects and their eggs; and will injure no foliage.

---

\*Insects Affecting the Orange, by H. G. Hubbard, United States Department of Agriculture, Division of Entomology, 1885, p. 94.

Professor Cook says "Many have complained of a lack of success in the use of kerosene emulsion. In such cases, I presume the explanation lies in the manner of making the application. We must bear in mind that the lice are well concealed and protected by the thousand leaves from which they are sucking the life, and a livelihood. Often the leaves curl up and thus make the protection more sure. But we must strike every louse or insect with the liquid. We cannot then turn or sprinkle on the liquid gently, we must dash it on with force, that every insect may be struck; then there will be no complaint of ill success. Thus the kerosene emulsion should always be applied with a good force pump. It is doubtless better to throw all liquid insecticides in spraying for injurious insects; with the kerosene emulsion, it is absolutely essential to success. The kerosene emulsion is superior to any other insecticide, so far as I have experimented in destroying plant-lice, scale or bark lice, many of the bugs, and not a few caterpillars, grubs and slugs."

With the above facts before him, the intelligent planter will be able to apply these several insecticides to the destruction of a great variety of injurious insects that attack other plants than the trees growing upon his premises. Of course, bearing in mind that the *poisons should never be used* to destroy insects that work upon vegetables or other articles of food. For these latter he can resort to the kerosene emulsion and also to the

#### PERSIAN INSECT POWDER,

or Pyrethrum, as it is generally called. This last named insecticide is composed of the finely pulverized flower heads and stems of a composite plant which bears some resemblance to the daisy, and is known botanically by the generic name Pyrethrum. Most of the home-made "insect powder" is the product of a California firm, and is put up for market as "Buhach." It is better to use this Buhach than to buy that of foreign make, for it loses its strength with age. Like the arsenites this may be used as a powder and dusted on the plants, but it is perhaps best to put it in water in the proportion of a heaping tablespoonful to two gallons of water. This insecticide kills by contact, and not by being eaten. It is a splendid household article that should be kept on hand for emergencies in the warfare against fleas, flies, lice, bed-bugs, etc. To be kept as fresh as possible, a tight box

or bottle is absolutely necessary. For house use a small bellows is essential so that the powder can be forced into the cracks and nooks where the insects take refuge. This insect powder is also a splendid remedy against fleas upon the bodies of pets, as cats and dogs. It is also a good plan for travelers to carry some of the powder along to use in self-protection against vermin of all kinds upon the body as well as in sleeping quarters.

There are other important insecticides that are occasionally resorted to by the economic entomologist or professional "bug doctor" in his many experiments with injurious insects; but these will not receive attention at present. Perhaps, in some future bulletin we will make some mention of them in connection with the insects for the destruction of which they are best suited.

---

In closing this bulletin I wish to state that it is our intention to continue the investigation of "tree claim" insects, as well as all other injurious forms found within the state, and therefore ask the co-operation of all who are willing to help in this matter. Since it is impossible for me to visit every locality, I add, for the convenience of those who are interested, the following directions for sending insects:

All inquiries about insects, injurious or otherwise, should be accompanied by specimens, the more the better. Such specimens, if dead, should be packed in some soft material, as cotton or wool, and inclosed in some stout tin or wooden box. They will come by mail for one cent per ounce. **INSECTS SHOULD NEVER BE INCLOSED LOOSE IN THE LETTER.** Whenever possible, larvæ (*i. e.*, grubs, caterpillars, maggots, etc.) should be packed alive in some tight tin box — the tighter the better, as air-holes are not needed — along with a supply of their appropriate food sufficient to last them on their journey; otherwise they generally die on the road and shrivel up. Send as full an account as possible of the habits of the insect respecting which you desire information; for example, what plant or plants it infests; whether it destroys the leaves, the buds, the twigs, or the stem; how long it has been known to you; what amount of damage it has done, etc. Such particulars are often not only of high scientific interest, but of great practical importance. **PACKAGES SHOULD BE MARKED WITH THE NAME OF THE SENDER,** and should be addressed to the Entomologist of the Agricultural Experiment Station, Nebraska Hall, Room 10, State University, Lincoln, Nebraska.



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